ALARIS Medical Systems, Inc.
9190 Activity Road
San Diego, CA 92126

ALARIS™
MEDICAL SYSTEMS

November 8, 2000

Attention: Biomedical Department
C0mmander Usamma Attn Nrmc-mmm-p
1423 Sultan Drive
Ft Detrick, MD 21702-9201

Re: ***Distribution of Service Bulletins***

Dear Sir or Madam:

Alaris Medical Systems is continuing with our program of mailing Service Bulletins on a quarterly basis. You will find one or more of the Bulletins enclosed with this letter. The Service Bulletins are designed to update the Technical Service Manual with the most current information for servicing and maintaining our equipment.

You should only be receiving Service Bulletins for the specific model of instrument or instruments at your facility. If you have any questions or require additional information please contact **Alaris Medical Systems Technical Support** at **800-854-7128 x6003.**

Alaris Medical Systems recognizes the need for technical personnel to be updated with current information and hopes that your facility will benefit from this program.

Sincerely

Rodny A. Hasler

Rodney A. Hasler
Sr. Manager of Product Support
Alaris Medical Systems

Enclosures

Improving and Extending the Quality of Human Life™

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MEDICAL SYSTEMS

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P.O. Box 85335, San Diego, CA 92186-5335

Service Bulletin 459

P/N 146526A

Service Bulletins are supplements to ALARIS Medical Technical Service/Maintenance Manuals.
For a complete list of all ALARIS Medical Service Bulletins, refer to: www.alarismed.com/bulletins.htm

Model Affected: Gemini® Volumetric Infusion Pump/Controller; 1340/1341
Date: June 2000
Subject: Rate Accuracy Specification and General Updates

Purpose

The purpose of this bulletin is to 1) clarify the accuracy specification, 2) provide updated specifications, and 3) provide various general statement updates, for Models 1340 and 1341.

Explanation

Various specifications and general maintenance/service manual statements have been identified as needing clarification and updating.

References

PC-4 (Model 1340/1341) Maintenance/Service Manual
(identified as P/N 1340-9217-00 or 143620; ordered as P/N 141882)

Parts and Tools Required

Not applicable.

Recommended Action

Use the following references in place of the corresponding information in the maintenance/service manual. Refer to the maintenance/service manual for all other specifications.

1. Performance Specifications

System Accuracy: Rate accuracy of the PC–4 infusion system is ±5%, 95% of the time with 95% confidence, under the conditions tested below. (*Refer to the Trumpet and Start–Up Curve, in this bulletin, for additional information.*)

Long term accuracy specified under the following conditions:

Disposable Type = Reorder #2210
Needle = 18 gauge x 1½"
Solution Type = ISO class III water
Environment/Temperature = 21-25°C (70-77°F)
Head Height = 24±2 inches (60.96±5.08 cm) from center of strain beam
Back Pressure = 0 psig (0 mmHg)
Infusion Range = 0.1–999 ml/hr

CAUTION

Variations of head height, back pressure, time, instrument tilt, or any combination of these, may affect rate accuracy. Factors that can influence head height and back pressure are: IV set configuration, IV solution viscosity and IV solution temperature. Back pressure may also be affected by type of catheter.

Air-In-Line Detection:	50 to 100 microliters
Volume-to-be-Infused (VTBI):	0.1-9999 ml in 1.0 ml increments 0.1-1000 in 0.1 ml increments

2. Physical Description

Depth: 9.5" (24.2 cm)
Weight: 26.2 lbs (11.9 kg), including power cord

3. Operating Requirements

Storage Temperature: 0 to 60°C

4. General Statement Updates

All references to:

- "10 psi mode"

  Ignore. This device does not have a 10 psi mode.

- "C2 Mode" or "Comp. Ctrl."

  Replace with "Factory Test Mode".

- Timed Low Battery Alarm

  Include: Time to Low Battery Advisory (LB-1) is 3.5 hours; Time to Low Battery Alarm (LB-2) is 4 hours.

- Volume of air detected which causes an alarm is 50 to 100 microliters.

  Ignore all other references.

- Gemini® administration sets are reorder #2210.

  Ignore all other references.

5. Trumpet and Start-Up Curves

In this instrument, as with all infusion systems, the action of the pumping mechanism and variations in individual administration sets cause short-term fluctuations in rate accuracy. The following curves show typical performance of the system in two ways:

a. the accuracy during various time periods over which fluid delivery is measured (trumpet curves), and

b. the delay in onset of fluid flow when infusion commences (start-up curves).

Trumpet curves are named for their characteristic shape. They display discrete accuracy data averaged over particular time periods or "observation windows", not continuous data versus operating time. Over long observation windows, short-term fluctuations have little effect on accuracy as represented by the flat part of the curve. As the observation window is reduced, short-term fluctuations have greater effect, as represented by the "mouth" of the trumpet. Knowledge of system accuracy over various observation windows may be of interest when certain drugs are being administered.

Because the clinical impact of short-term fluctuations on rate accuracy depends on the half-life of the drug being infused and on the degree of intravascular integration, the clinical effect cannot be determined from the trumpet curves alone. Knowledge of the start-up characteristics should also be considered.

The start-up curves represent continuous flow rate versus operating time for two hours from the start of the infusion. They exhibit the delay in onset of delivery due to mechanical compliance and provide a visual representation of uniformity. Trumpet curves are derived from the second hour of this data.

5. Trumpet and Start-Up Curves (Continued)

Effects of Pressure Variations

Under conditions of +100 mmHg pressure, the PC–4 typically exhibits a long-term accuracy offset of approximately -1.7% from mean values.

Under conditions of –100 mmHg pressure, the PC–4 typically exhibits a long-term accuracy offset of approximately +3.5% from mean values.

Under conditions of +300 mmHg pressure, the PC–4 typically exhibits a long-term accuracy offset of approximately -4.8% from mean values.

Resulting Trumpet observation points typically track those of accuracy; therefore, no significant change in short term variations result under these pressure conditions.

Effects of Negative Solution Container Heights

With a negative head height of -0.5 meters, the PC–4 typically exhibits a long-term volume delivery accuracy offset of approximately -5.8% from mean values.

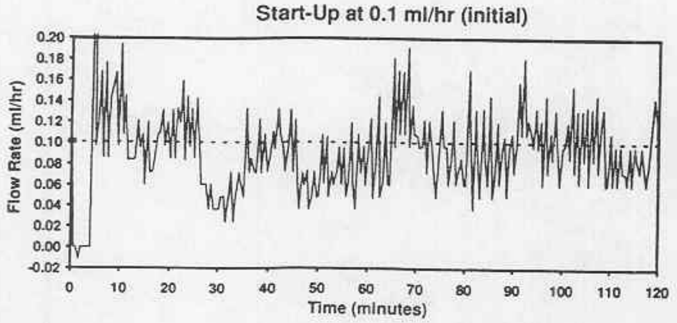
Resulting Trumpet observation points typically track those of accuracy; therefore, no significant change in short term variations result under negative head height conditions.

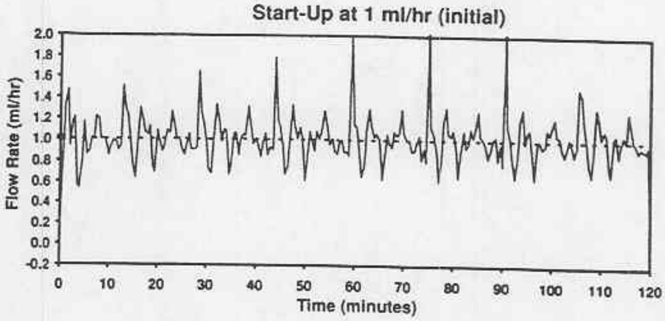
Effects of Rate

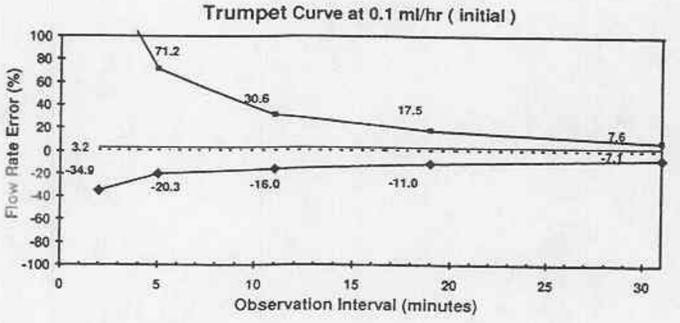
For applications where flow uniformity is a concern, rates of 1.0 ml/hr or above are recommended.

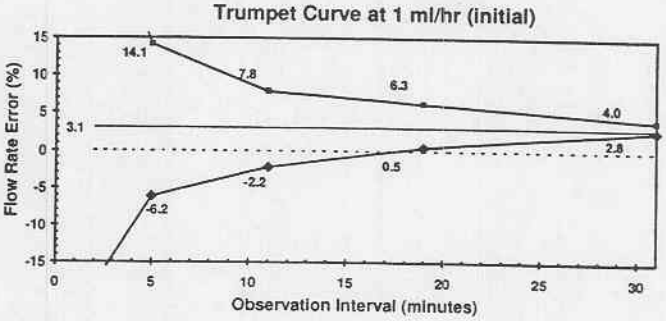
Tests performed per IEC 60601-2-24, "Particular Requirements for Safety of Infusion Pumps and Controllers" and AAMI ID26 1998, using Gemini® reorder number 2210 intravenous administration sets.

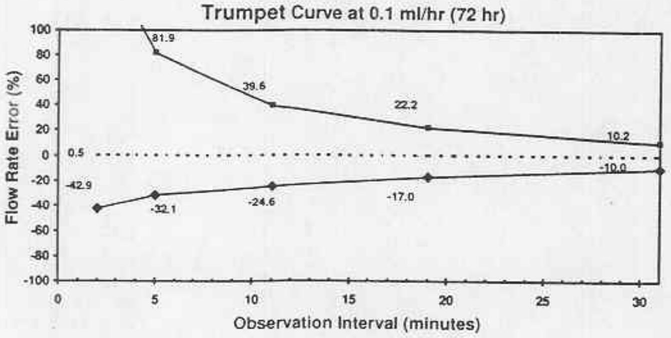
5. Trumpet and Start-Up Curves (Continued)

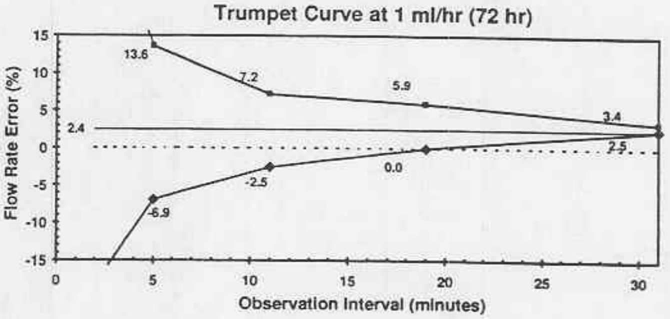

Start-Up at 0.1 ml/hr (initial)


Start-Up at 1 ml/hr (initial)


Trumpet Curve at 0.1 ml/hr (initial)


Trumpet Curve at 1 ml/hr (initial)


Trumpet Curve at 0.1 ml/hr (72 hr)

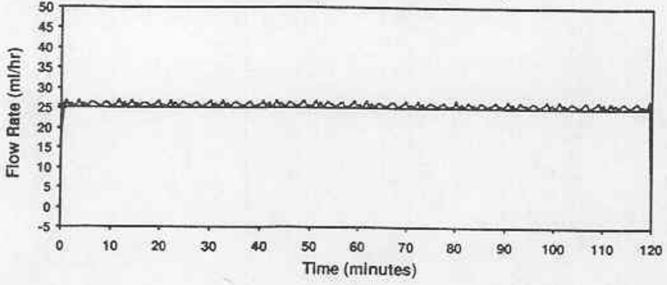

Trumpet Curve at 1 ml/hr (72 hr)

NOTE: The plot range for 0.1 ml/hr graphs has been increased to ±100% to allow visualization of the graph.

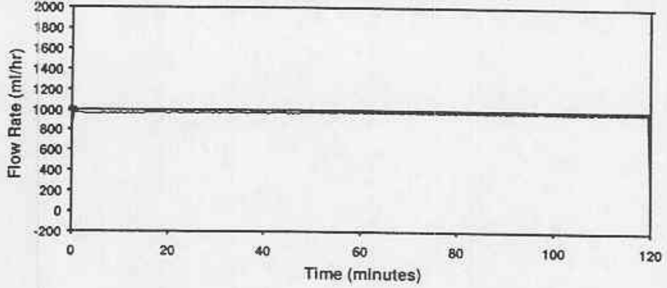
Legend

■ Maximum rate error
– Overall rate error
◆ Minimum rate error

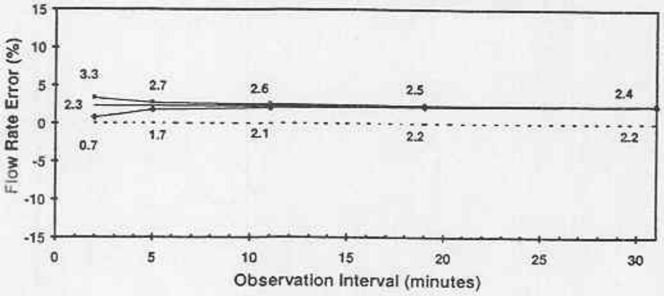
5. Trumpet and Start-Up Curves (Continued)



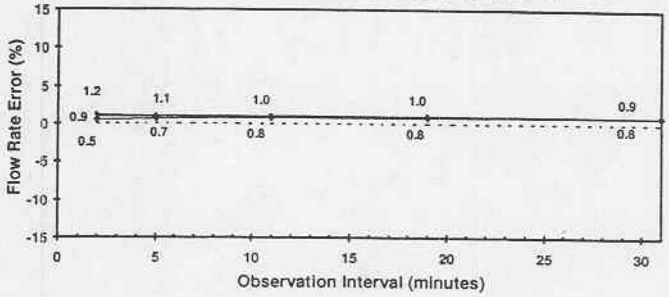
Start-Up at 25 ml/hr (initial)



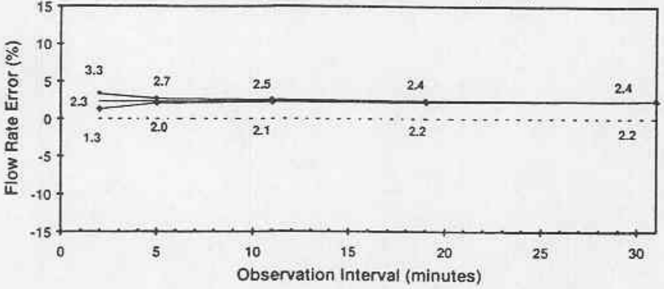
Start-Up at 999 ml/hr (initial)



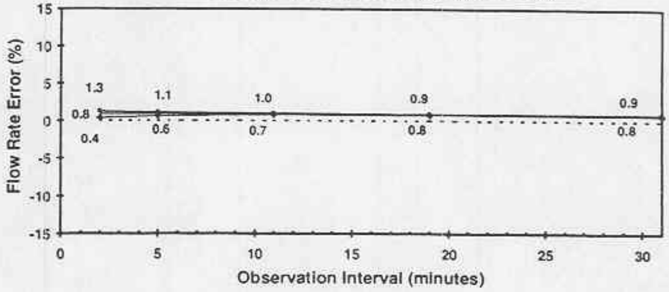
Trumpet Curve at 25 ml/hr (initial)



Trumpet Curve at 999 ml/hr (initial)



Trumpet Curve at 25 ml/hr (72 hr)



Trumpet Curve at 999 ml/hr (24 hr)

Legend

■ Maximum rate error
– Overall rate error
◆ Minimum rate error

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Service Bulletin 468

P/N 146517A

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Model Affected: Gemini® Volumetric Infusion Pump/Controller; 1340 (PC-4)
Date: June 2000
Subject: Release of Model 1340J

Purpose

The purpose of this bulletin is to provide Biomedical Technicians information related to the release of Model 1340J (115V).

Explanation

The software has been updated to Version 1.93 and instruments having this version software are referred to as a Model 1340J. The only difference between the Model 1340J and the Model 1340E (previous configuration) is the software version and the Directions for Use.

Version 1.93 software incorporates the following changes:

- The "event history display" and "logged data" menu items, originally included under S/C Board Tests and Displays in the Maintenance Mode, are no longer available.
- The confirmation pop-up box that is enabled when a drug calculation setup is temporarily exited has had its text changed to:

  "**Programming on Channel X has not been completed. Press ENTER to complete/confirm. Press CANCEL to clear program.**"

  NOTE: The "X" represents the channel designation (A, B, C, or D).
- If an integer primary rate is entered and a fractional secondary rate entry is attempted, the data entered prior to the decimal entry will be cleared and "**Illegal value entered**" will be displayed, replacing the double beep.
- When the Time key is pressed during infusion, a pop-up box will read:

  "**Time Values will change the rate. Press ENTER to confirm. Press CANCEL to reprogram.**"
- When making a year entry in the Clock Setup menu all entries from "00" through "69" will be interpreted as being in the 21st century (2000's), and all other entries will be interpreted as being in the 20th century (1900's).

Explanation (Continued)

- The potential for the instrument to exhibit an error 838 and shut down, when an error X07 has occurred and the door is left open, has been eliminated.
- The potential for the instrument to exhibit an error related to "Rapid Key Presses" or a system overload, has been reduced.

Various new parts are for specific use with the Model 1340J, as follows:

Part		Differences
Transformer/Harness Assembly	----	115V (instead of 110V)
SPC Board/Harness Assembly	----	5A fuses (instead of 2.5A)
Power Supply Board Assembly	----	5A fuse (instead of 4A)
Ground/Fuse Label	----	references 0.6A for 115V (instead of 0.4A)
Line Fuse	----	0.6A for 115V (instead of 0.4A)
Receptacle/Fuse Assembly	----	0.6A fuse for 115V (instead of 0.4A)

References

PC-4 (Model 1340) Maintenance/Service Manual
(*identified as P/N 1340-9217-00 or 143620; ordered as P/N 141882*)

Parts and Tools Required

Reference the appropriate sections of the service manual if servicing becomes necessary.

Recommended Action

Include the following information, as a service manual reference, when repairing a Model 1340 having a 115V transformer. Part numbers not listed below remain the same as for a Model 1340 having a 110V transformer. (*Supplement to Principles of Operation and Illustrated Parts Breakdown chapters of service/maintenance manual.*)

Literature:

Part Number	Description
146120	Directions for Use, English

Pump Assembly:

Item	Part Number	Description	Qty.
640	143675	Label, Ground/Fuse, English, 0.6A (1340J)	1
670	144817	Label Sheet, Rear, English The sheet includes one each of the following labels: Com/Audio/ECD (1340) 0.6A Ground/Fuse (1340J) Nameplate (1340) Warning (1340)	1

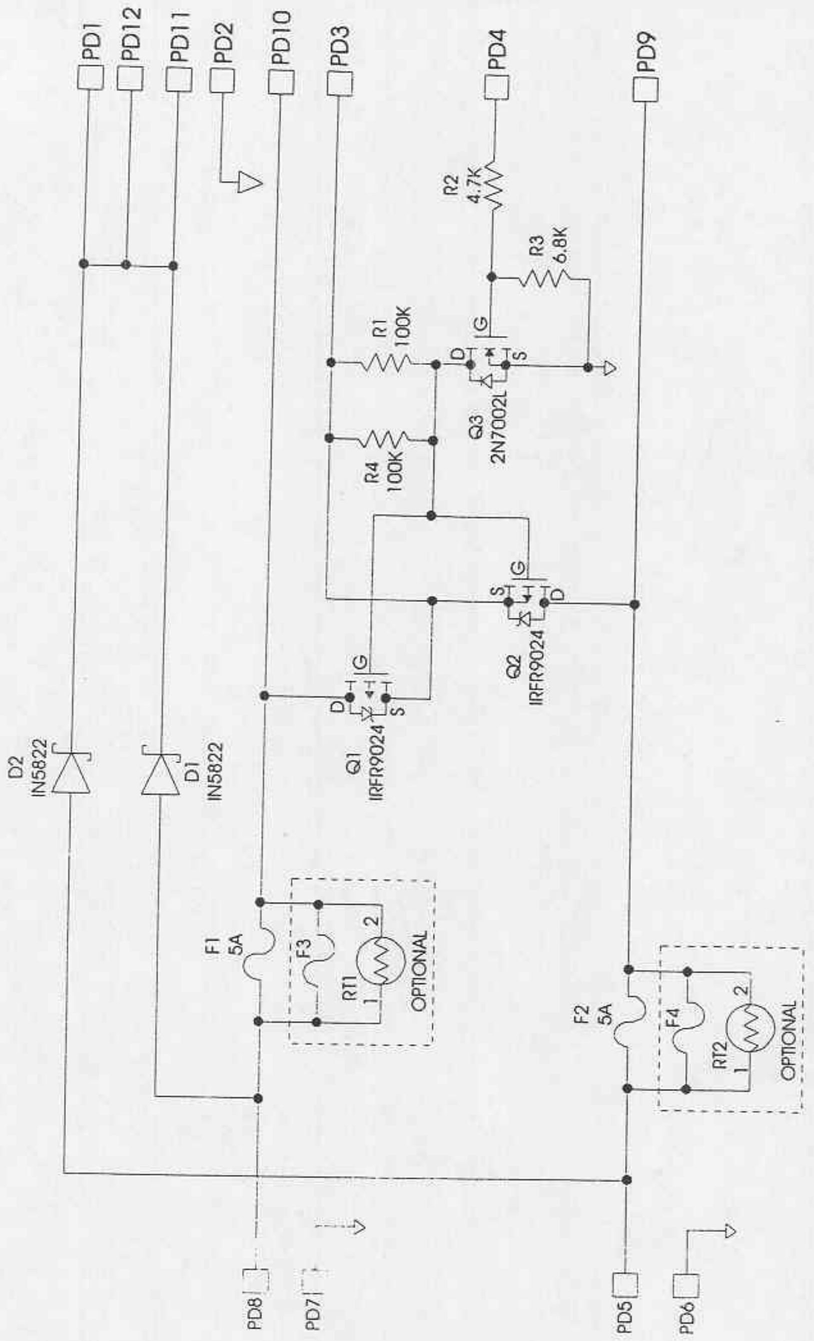
Rear Case Assembly:

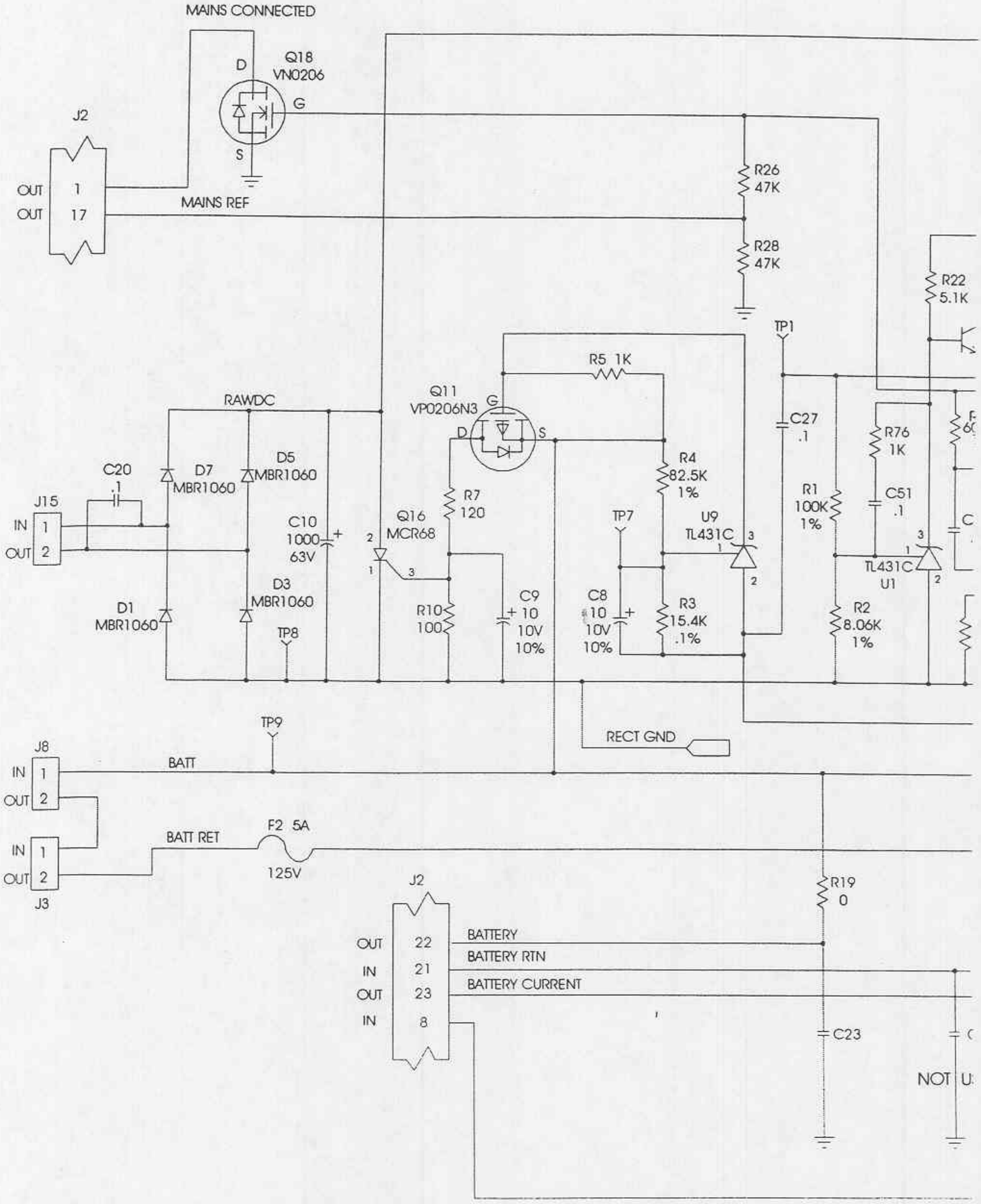
Item	Part Number	Description	Qty.
015	144834	SPC (Daughter) Board/Harness Assembly, 5A	1
400		Receptacle/Line Fuse	1
	144833	Receptacle/0.6A Fuse Assembly (1340J)	
	842028	Fuse, 3AG Type, 0.6A, 250V, Slow-Blow (1340J)	
420	143654	Transformer/Harness Assembly, 115V (1340J)	1
430	144837	Power Supply Board Assembly, 5A	1

Power Supply Board Assembly:

Ref Des	Part Number	Description	Qty.
	144837	Power Supply Board Assembly, 5A	1
F002	842001	Fuse, PICO, 5A, 125V, AXL	1
R011	810563-R05	RES, WW, 3W, 1%, 0.05, AXL	1

SPC Board/Harness (5A) Schematic – Model 1340 (having 115V Transformer)


PD1
PD12
PD11
PD2
PD10
PD3
PD4
PD9
R2
4.7K
R3
6.8K
R1
100K
R4
100K
Q3
2N7002L
Q2
IRFR9024
Q1
IRFR9024
D
G
S
D2
IN5822
D1
IN5822
F1
5A
F3
RT1
1
2
OPTIONAL
F2
5A
F4
RT2
1
2
OPTIONAL
PD8
PD7
PD5
PD6


MAINS CONNECTED
Q18
VN0206
D
G
S
J2
OUT 1
OUT 17
MAINS REF
R26
47K
R28
47K
R22
5.1K
TP1
R5 1K
Q11
VP0206N3
G
D
S
RAWDC
C20
.1
J15
IN 1
OUT 2
D7
MBR1060
D5
MBR1060
C10
1000
63V
+
2
1
3
Q16
MCR68
R7
120
C27
.1
R4
82.5K
1%
R76
1K
C51
.1
R1
100K
1%
TP7
U9
TL431C
1
3
2
TL431C
U1
1
3
2
C
D3
MBR1060
D1
MBR1060
TP8
R10
100
C9
+ 10
10V
10%
C8
10
10V
10%
+
R3
15.4K
.1%
R2
8.06K
1%
RECT GND
TP9
J8
IN 1
OUT 2
BATT
IN 1
OUT 2
J3
BATT RET
F2 5A
125V
R19
0
J2
OUT 22
IN 21
OUT 23
IN 8
BATTERY
BATTERY RTN
BATTERY CURRENT
C23
NOT U

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Service Bulletin 469

P/N 146519A

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Model Affected: Gemini® Volumetric Infusion Pump/Controller; 1340/1341 (PC-4)
Date: June 2000
Subject: Release of Models 1340H and 1341D

Purpose

The purpose of this bulletin is to provide Biomedical Technicians information related to the release of Models 1340H and 1341D.

Explanation

The software has been updated to Version 1.93 and instruments having this version software are referred to as Models 1340H and 1341D.

Instruments having Version 5.10.18.0 or earlier software use a 6V lead acid battery and must be upgraded to a 12V battery configuration before being upgraded to Version 1.93 software.

Version 1.93 software incorporates the following changes:

- The "event history display" and "logged data" menu items, originally included under S/C Board Tests and Displays in the Maintenance Mode, are no longer available.
- The confirmation pop-up box that is enabled when a drug calculation setup is temporarily exited has had its text changed to:

  "**Programming on Channel X has not been completed. Press ENTER to complete/confirm. Press CANCEL to clear program.**"

  NOTE: The "X" represents the channel designation (A, B, C, or D).
- If an integer primary rate is entered and a fractional secondary rate entry is attempted, the data entered prior to the decimal entry will be cleared and "**Illegal value entered**" will be displayed, replacing the double beep.
- When the Time key is pressed during infusion, a pop-up box will read:

  "**Time Values will change the rate. Press ENTER to confirm. Press CANCEL to reprogram.**"
- When making a year entry in the Clock Setup menu all entries from "00" through "69" will be interpreted as being in the 21st century (2000's), and all other entries will be interpreted as being in the 20th century (1900's).

Explanation (Continued)

- The potential for the instrument to exhibit an error 838 and shut down, when an error X07 has occurred and the door is left open, has been eliminated.
- The potential for the instrument to exhibit an error related to "Rapid Key Presses" or a system overload, has been reduced.

References

PC-4 (Model 1340/1341) Maintenance/Service Manual
(*identified as P/N 1340-9217-00 or 143620; ordered as P/N 141882*)

Parts and Tools Required

Reference the appropriate sections of the service manual if servicing becomes necessary.

CAUTION

If replacement of the programmed EPROMs becomes necessary ensure that the proper IC removal tool is used to remove them from the logic board assembly. The EPROMs could be damaged if removed with the incorrect tool. A Burndy IC removal tool is recommended.

Recommended Action

Prior to placing an order for a Battery, Directions for Use, Logic Board Assembly, Power Supply Board Assembly, or Programmed Memory Assembly, determine the instrument's software version, as follows:

1. Power the instrument on.
2. Press the OPTIONS/EDIT key to access the System Configuration viewing screens.
3. Select screen 5 to display the software version.

NOTE: The software version identified on the programmed EPROMs, U30 and U31 on the logic board assembly, may be different than the software version displayed on the System Configuration screen. This will occur if a software update was accomplished by flashing.

Parts Breakdown (*Supplement to Illustrated Parts Breakdown chapter of maintenance manual*)

If an instrument having Version 5.10.18.0 or earlier software (6V battery configuration) requires repair, and any of the following parts are needed, contact ALARIS Medical Systems™, Technical Support, for instructions on where to return the instrument for upgrading to the latest configuration (12V battery).

Battery, Lead Acid, 12V
Logic Board Assembly
Power Supply Board Assembly
Logic IC, Programmed (U30, U31)

1. Use the following information when ordering any of the listed parts for Models 1340 and 1341 with Version 5.11.17.0 or later software.

Part Number	Description
146120	Directions for Use, English (1340H/1341D)
	Logic Board Assembly
146505	Kit, Upgrade to Version 1.93 (from 5.11.17.0, 7.05.05.0 or 1.85) (Kit consists of logic board assembly, English Directions for Use, serial number replacement label, upgrade report form, and installation instructions.)
146522	Version 1.93 replacement
	Memory Assembly
146507	Kit, Upgrade to Version 1.93 (from 5.11.17.0, 7.05.05.0 or 1.85) (Kit consists of programmed EPROMs, English Directions for Use, serial number replacement label, upgrade report form, controller board components for X07 errors, logic board components for false watchdog alarms, and installation instructions.)
146504	Version 1.93 replacement

2. Logic Board Assembly (Models 1340 and 1341)
(*Supplement to Illustrated Parts Breakdown chapter of Maintenance Manual*)

Ref Des	Part Number	Description	Qty.
	146522	Board Assembly, Logic	1
		Capacitors	
C1, C2	811245300A	Cap, Cer, COG, 50V, 15%, 30pF, AX	2
C3	811137475A	Cap, Tant, 20V, 20%, 4.7µF, AX	1
C4, C6, C16	811116106A	Cap, Tant, 10V, 10%, 10µF. AX	3
C5	811116396A	Cap, Tant, 10V, 10%, 39µF, AX	1
C7, C60	811256821A	Cap, Cer, X7R, 50V, 10%, 820pF, AX	2

2. Logic Board Assembly (Continued)

Capacitors (Continued)

Ref Des	Part Number	Description	Qty.
C8, C9, C10, C11, C12, C13, C14, C15, C17, C18, C19, C20, C21, C22, C23, C24, C25, C33, C38, C44, C45, C51, C52, C53, C54, C55, C56, C57, C58, C59	811246103A	Cap, Cer, X7R, 50V, 10%, .01µF, AX	30
C26	811257220A	Cap, Cer, 100V, 20%, 22pF, COG, AX	1
C27	811256100A	Cap, Cer, COG, 50V, 10%, 10pF, AX	1
C28	811247224A	Cap, Cer, Z5U, 50V, 20%, .22µF, AX	1
C29, C30, C31, C34, C40, C41, C42, C43, C50	811247104A	Cap, Cer, Z5U, 50V, 20%, .1µF, AX	9
C32	811247474A	Cap, Cer, Z5U, 50V, 20%, .47µF, AX	1
C35	811247150A	Cap, Cer, COG, 50V, 20%, 15pF, AX	1
C36	811246101A	Cap, Cer, COG, 50V, 10%, 100pF, AX	1
C37, C48	811136105A	Cap, Tant, 20V, 10%, 1µF, AX	2
C39	811245221A	Cap, Cer, COG, 50V, 5%, 220pF, AX	1
C49	811116107A	Cap, Tant, 10V, 10%, 100µF, AX	1
C61	811247102A	Cap, Cer, X7R, 50V, 20%, .001µF, AX	1
CA001	811947-103	Cap, 50V, 20%, .01µF, SIP	1

Diodes

Ref Des	Part Number	Description	Qty.
D1, D3, D4, D5, D8	813500	Diode, Silicone Switching 75V	5
D2, D6, D9	813019	Diode, 1N5711 Schottky	3

Transistors

Ref Des	Part Number	Description	Qty.
Q1, Q2, Q3, Q5	814005	FET, N-CHNNL, 3.0 Amp, VN026	4
Q4, Q6	814006	XSTR, FET, N-CHA, VN22	2

2. Logic Board Assembly (Continued)

Integrated Circuits

Ref Des	Part Number	Description	Qty.
U1	812260	IC, 80C188 Embedded Processor	1
U2, U3	812265	IC, 27M7, 500UV, OP-Amp	2
U4	812061	IC, CMOS, Voltage Converter	1
U5	812095	IC, 74HC4060 HS CMOS LGC Family	1
U6, U10	812227	IC, 74ACT573, Octal Latch	2
U8	812249	IC, Static RAM, 128X8	1
U9	812138	IC, 74HC245 HS CMOS LGC Family	1
U11	812103	IC, 74HC32 HS CMOS LGC Family	1
U12, U20	812258	IC, 74ACT04, Hex Invertor	2
U13, U16	812259	IC, 74ACT574, Octal Flip Flop	2
U15	812139	IC, 74HC573 HS CMOS LGC Family	1
U17	812255	IC, 74ACT08, Quad 2 In and Gate	1
U19	812262	IC, 74ACT14, HEX INV, Schmidt	1
U21	812205	IC, 74HC132 HS CMOS LGC Family	1
U22	812254	IC, 74ACT139, 2 To 4 Line Decoder	1
U23	812252	IC, 74HCT367 Hex Buffer 3 State	1
U24	812042	IC, LM358 Dual OP Amp PLSTC	1
U25	20-1037-1	IC, EPLD	1
U26	812245	IC, CMOS, 8-Bit, BFR, MULT, DAC	1
U27	812243	IC, PRGMMBL INTRPT Controller	1
U28	812229	IC, 2950, 5V Regulator	1
U29	812248	IC, MC146818, RT CLK, W/RAM, 24DIP	1
U30	146459	IC, PRGM 142359:1.93	1
U31	146460	IC, PRGRM 142359:1.93	1
U32	812251	IC, ADC0808, 8-BIT A/D Converter	1
U34	812022	IC, 3503 2.5 Volt Ref	1
U35, U37	812220	IC, 74ACT32, QUAD2 Input or Gate	2

Resistors

Ref Des	Part Number	Description	Qty.
R1, R9, R16, R28, R29, R37, R39, R51, R52	810125-103	CFR, 1/4W, 5%, 10K	9
R2, R3, R25	8102214022	Res, MET FLM, 1/4W, .1%, 40.2K	3
R4, R5	8102212151	Res, MET FLM, 1/4W, .1%, 2.15K	2

2. Logic Board Assembly (Continued)

Resistors (Continued)

Ref Des	Part Number	Description	Qty.
R6, R14, R18, R19	8102211003	Res, MET FLM, 1/4W, .1%, 100K	4
R7, R17, R23	8102191823	Res, MET FLM, 1/8W, .25%, 182K	3
R8, R21, R27, R32, R38, R41, R45, R46, R47, R48, R49, R50	810125-104	CFR, 1/4W, 5%, 100K	12
R10	810125-335	CFR, 1/4W, 5%, 3.3M	1
R11, R63	810125-102	CFR, 1/4W, 5%, 1K	2
R12, R13	8102192492	Res, MET FLM, 1/4W, .25%, 24.9K	2
R15	8102298252	Res, MET FLM, 1/4W, 1%, 82.5K, AX	1
R20, R34	8102233323	Res, MET FLM, 1/4W, 1%, 332K	2
R22	810125-474	CFR, 1/4W, 5%, 470K	1
R24, R36	810125-186	CFR, 1/4W, 5%, 18M	2
R26	810125-394	CFR, 1/4W, 5%, 390K	1
R30	810125-225	CFR, 1/4W, 5%, 2.2M	1
R31, R44	810125-204	CFR, 1/4W, 5%, 200K	2
R33	810229-104	Res, MET FLM, 1/4W, 1%, 100K	1
R35	810125-473	CFR, 1/4W, 5%, 47K	1
R40	810229-153	Res, MET FLM, 1/4W, 1%, 15K	1
R42	810125-332	CFR, 1/4W, 5%, 3.3K	1
R43	810125-560	CFR, 1/4W, 5%, 56	1
R59, R60, R61, R62	810125-101	CFR, 1/4W, 5%, 100	4
RA1, RA3, RA4, RA5, RA6	810900-473	Res, SIP, .2W, 2%, 47K, 10 Bus	5

Miscellaneous

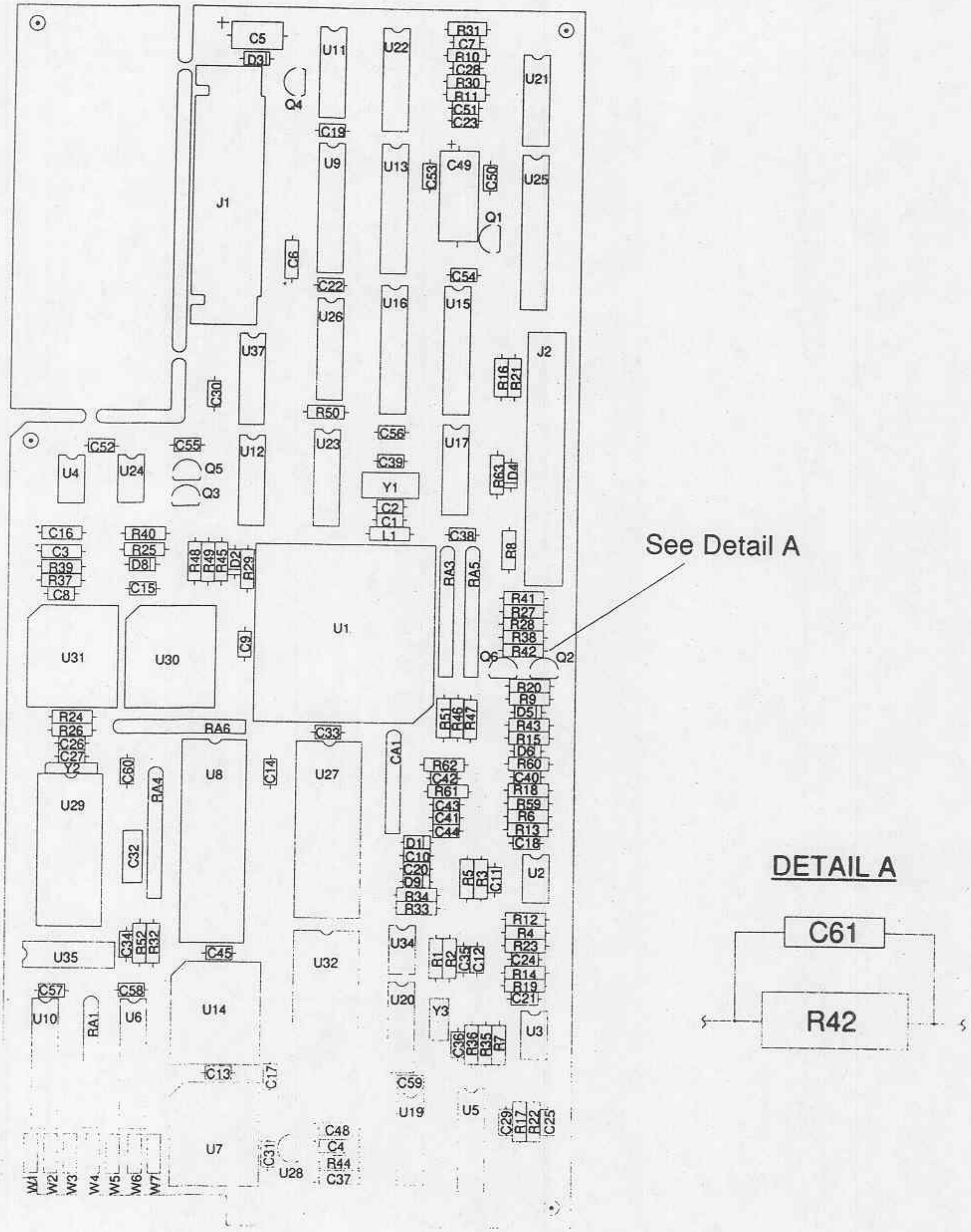
J1	856083	Conn, RT Angle SKT RCPT, 60Pin	1
J2	851079	Conn, 4WL HDR, PC MT, 34CKT .1X.1	1
Y1	815089	XTAL, 199 HI, 32MHz, 3RD Overtone	1
Y2	815060	XTAL, TUN FK RESN, 32.786 kHz	1
Y3	815012	Resonator, Piezoelectric 480kHz	1
XU1	856085	Conn, SKT, 84 Pin PLCC	1

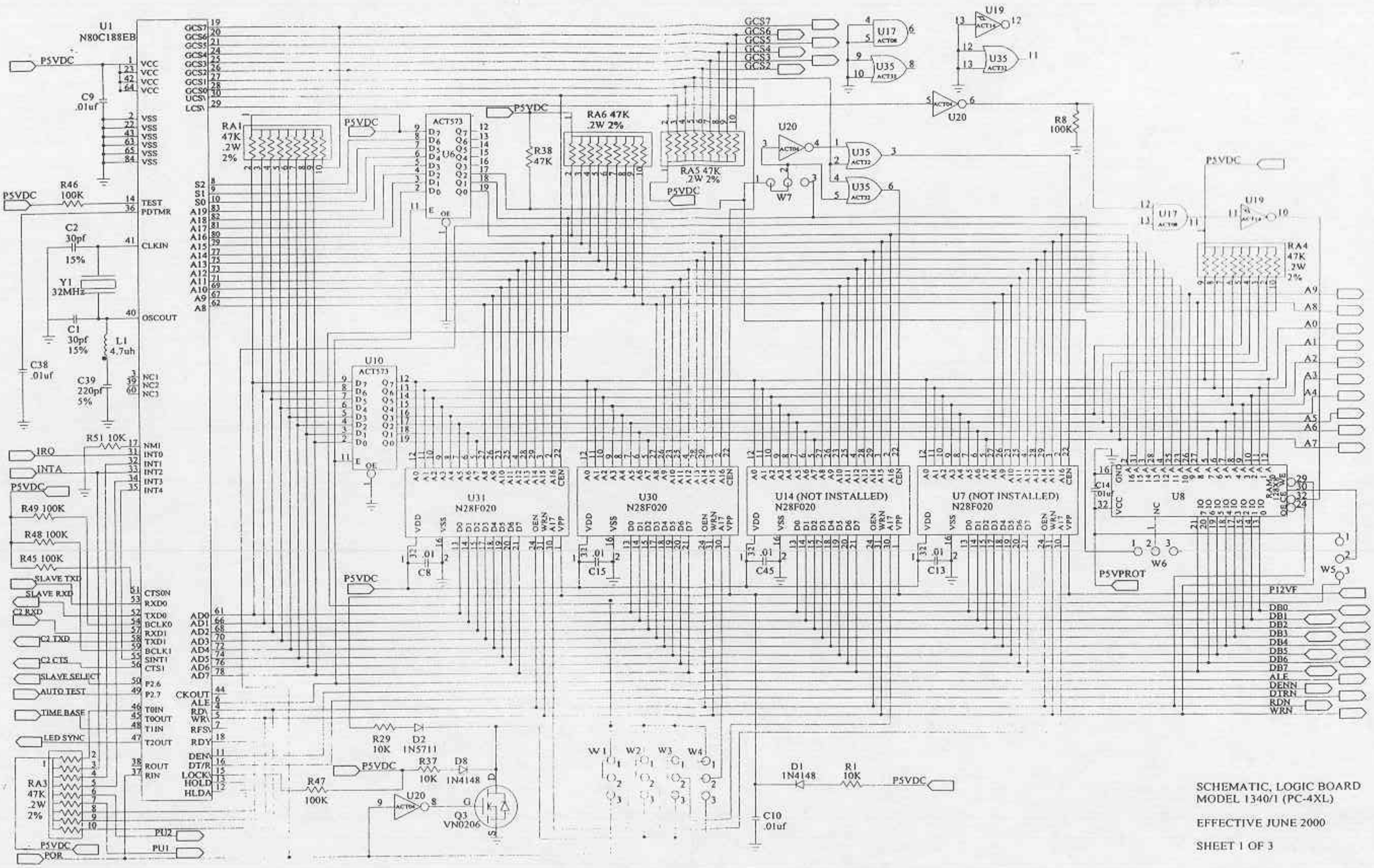
2. Logic Board Assembly (Continued)

Miscellaneous (Continued)

Ref Des	Part Number	Description	Qty.
XU7, XU14, XU30, XU31	856035	SKT, IC, PLCC-THD, 32 Pin	4
XU25	815002-4	SKT Low PF DIP Open FR 24 Pin	1
L1	815070	IDCTR, 4.7µH, 10%, 1.2 Ohm Axial	1
W1, W2, W3, W4, W5, W6, W7	851083	Conn, UNSHRD HDR, 1X3	7

2. Logic Board Assembly (Continued)

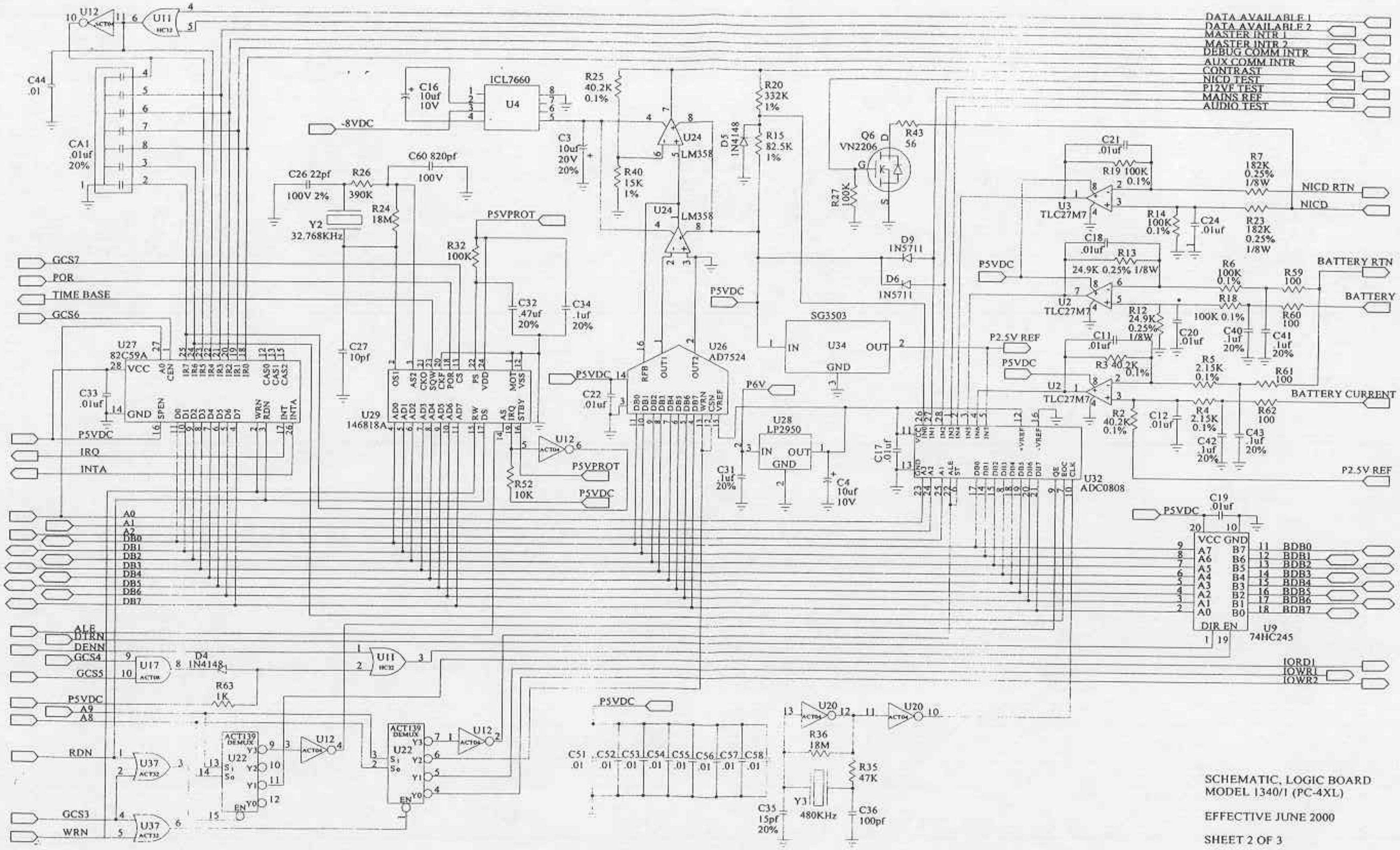

C5
D3
Q4
U11
U22
R31
C7
R10
C28
R30
R11
C51
C23
U21
J1
C19
U9
U13
C53
C49
C50
U25
Q1
C6
C22
C54
U26
U16
U15
J2
U37
R16
R21
C30
R50
C56
U12
U23
U17
C52
C55
Q5
Q3
U4
U24
C39
Y1
R63
D4
C2
C1
L1
C38
C16
C3
R39
R37
C8
R40
R25
D8
C15
R48
R49
R45
D2
R29
RA3
RA5
R8
R41
R27
R28
R38
R42
Q6
Q2
U31
U30
C9
U1
R20
R9
D5
R43
R15
D6
R60
C40
R18
R59
R6
R13
C18
R51
R46
R47
R24
R26
C26
C27
Y2
RA6
C33
CA1
R62
C42
R61
C43
C41
C44
U29
C60
RA4
U8
C14
U27
C32
D1
C10
C20
D9
R34
R33
R5
R3
C11
U2
R12
R4
R23
C24
R14
R19
C21
C34
R52
R32
U35
C45
U32
U34
R1
R2
C35
C12
C57
C58
U10
RA1
U6
U14
U20
Y3
U3
C36
R36
R35
R7
C13
C17
C59
U19
U5
C29
R17
R22
C25
C48
C4
R44
C37
U7
C31
U28
W1
W2
W3
W4
W5
W6
W7
See Detail A
DETAIL A
C61
R42


U1
N80C188EB
P5VDC
C9 .01uf
R46 100K
C2 30pf 15%
Y1 32MHz
C1 30pf 15%
L1 4.7uh
C38 .01uf
C39 220pf 5%
R51 10K
IRQ
INTA
R49 100K
R48 100K
R45 100K
SLAVE TXD
SLAVE RXD
C2 RXD
C2 TXD
C2 CTS
SLAVE SELECT
AUTO TEST
TIME BASE
LED SYNC
RA3 47K .2W 2%
POR
PU2
PU1
RA1 47K .2W 2%
U6 ACT573
U10 ACT573
RA6 47K .2W 2%
R38 47K
RA5 47K .2W 2%
U20
W7
U35
U17
U19
R8 100K
RA4 47K .2W 2%
U31 N28F020
U30 N28F020
U14 (NOT INSTALLED) N28F020
U7 (NOT INSTALLED) N28F020
U8
C8
C15
C45
C13
C14 .01uf
W6
P5VPROT
W5
P12VF
DB0
DB1
DB2
DB3
DB4
DB5
DB6
DB7
ALE
DENN
DTRN
RDN
WRN
A9
A8
A0
A1
A2
A3
A4
A5
A6
A7
GCS7
GCS6
GCS5
GCS4
GCS3
GCS2
R29 10K
D2 1N5711
R37 10K
D8 1N4148
Q3 VN0206
R47 100K
W1
W2
W3
W4
D1 1N4148
R1 10K
C10 .01uf

SCHEMATIC, LOGIC BOARD
MODEL 1340/1 (PC-4XL)

EFFECTIVE JUNE 2000

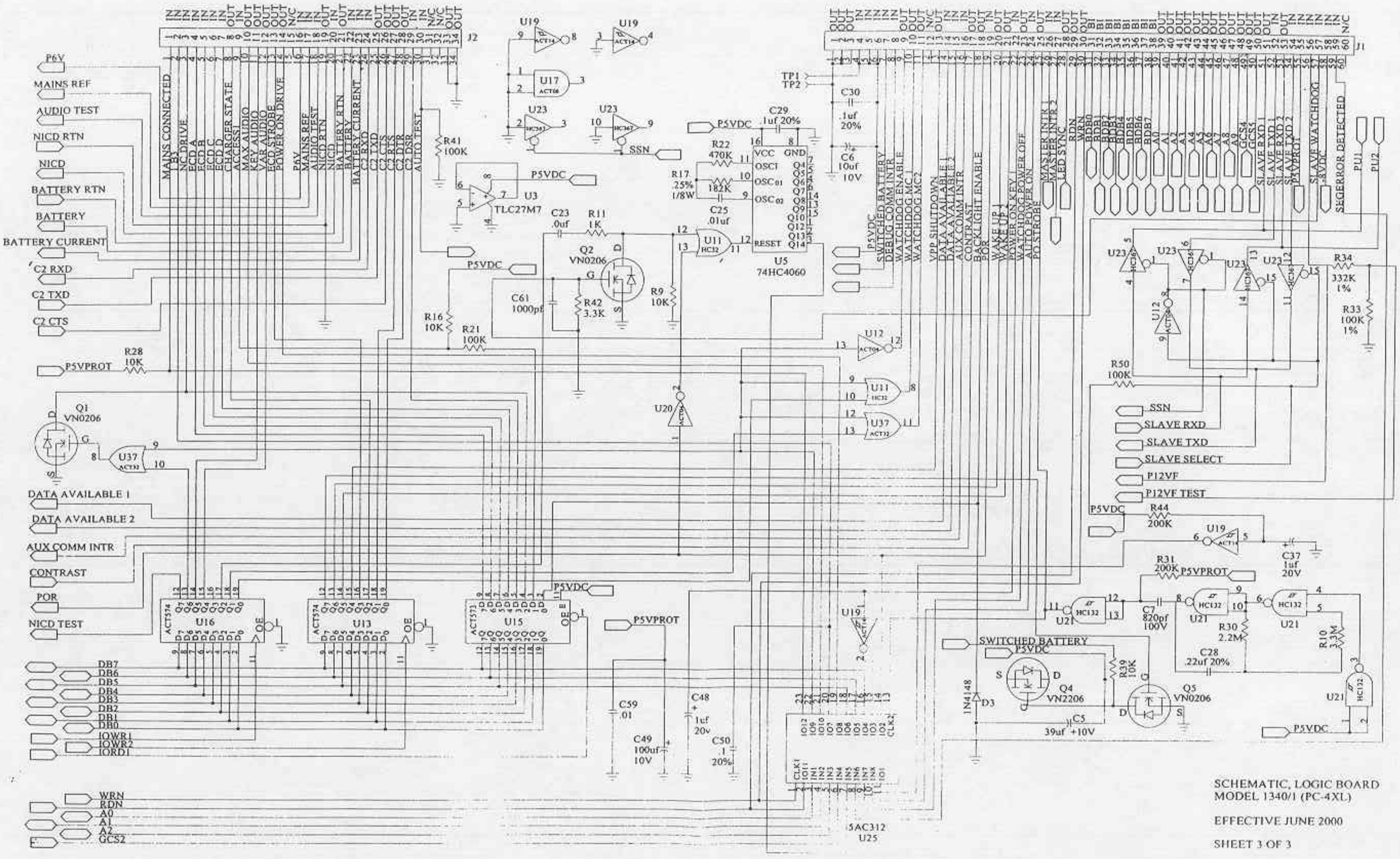
SHEET 1 OF 3


DATA AVAILABLE 1
DATA AVAILABLE 2
MASTER INTR 1
MASTER INTR 2
DEBUG COMM INTR
AUX COMM INTR
CONTRAST
NICD TEST
P12VF TEST
MAINS REF
AUDIO TEST
NICD RTN
NICD
BATTERY RTN
BATTERY
BATTERY CURRENT
P2.5V REF
GCS7
POR
TIME BASE
GCS6
P5VDC
IRQ
INTA
A0
A1
A2
DB0
DB1
DB2
DB3
DB4
DB5
DB6
DB7
ALE
DTRN
DENN
GCS4
GCS5
A9
A8
RDN
GCS3
WRN
BDB0
BDB1
BDB2
BDB3
BDB4
BDB5
BDB6
BDB7
IORD1
IOWR1
IOWR2
U27 82C59A
U29 146818A
U4 ICL7660
U24 LM358
U26 AD7524
U34 SG3503
U28 LP2950
U32 ADC0808
U9 74HC245
U3 TLC27M7
U2 TLC27M7
U22 ACT139 DEMUX
U37 ACT32
U17 ACT08
U11 HC32
U12 ACT04
U20 ACT04
Q6 VN2206
Y2 32.768KHz
Y3 480KHz
-8VDC
P5VPROT
P6V
C44 .01
CA1 .01uf 20%
C16 10uf 10V
C26 22pf 100V 2%
R26 390K
R24 18M
C60 820pf 100V
C27 10pf
R32 100K
C32 .47uf 20%
C34 .1uf 20%
C33 .01uf
R25 40.2K 0.1%
C3 10uf 20V 20%
R40 15K 1%
R20 332K 1%
R15 82.5K 1%
D5 1N4148
R27 100K
R43 56
D9 1N5711
D6 1N5711
C22 .01uf
R52 10K
C31 .1uf 20%
C4 10uf 10V
C17 .01uf
C21 .01uf
R19 100K 0.1%
R7 182K 0.25% 1/8W
R14 100K 0.1%
C24 .01uf
R23 182K 0.25% 1/8W
C18 .01uf
R13 24.9K 0.25% 1/8W
R6 100K 0.1%
R59 100
R18 100K 0.1%
R60 100
R12 24.9K 0.25% 1/8W
C20 .01uf
C40 .1uf 20%
C41 .1uf 20%
C11 .01uf
R3 40.2K 0.1%
R5 2.15K 0.1%
R61 100
R2 40.2K 0.1%
C12 .01uf
R4 2.15K 0.1%
R62 100
C42 .1uf 20%
C43 .1uf 20%
C19 .01uf
D4 1N4148
R63 1K
C51 .01
C52 .01
C53 .01
C54 .01
C55 .01
C56 .01
C57 .01
C58 .01
R36 18M
R35 47K
C35 15pf 20%
C36 100pf

SCHEMATIC, LOGIC BOARD
MODEL 1340/1 (PC-4XL)

EFFECTIVE JUNE 2000

SHEET 2 OF 3


J2
J1
P6V
MAINS REF
AUDIO TEST
NICD RTN
NICD
BATTERY RTN
BATTERY
BATTERY CURRENT
C2 RXD
C2 TXD
C2 CTS
P5VPROT
R28 10K
Q1 VN0206
U37 ACT32
DATA AVAILABLE 1
DATA AVAILABLE 2
AUX COMM INTR
CONTRAST
POR
NICD TEST
DB7
DB6
DB5
DB4
DB3
DB2
DB1
DB0
IOWR1
IOWR2
IORD1
WRN
RDN
A0
A1
A2
GCS2
MAINS CONNECTED
LB3
NC DRIVE
ECD A
ECD B
ECD C
ECD D
CHARGER STATE
ACCESS1
MAX AUDIO
KEY AUDIO
VAR AUDIO
ECD STROBE
POWER ON DRIVE
P6V
MAINS REF
AUDIO TEST
NICD RTN
NICD
BATTERY RTN
BATTERY
BATTERY CURRENT
C2 RXD
C2 TXD
C2 CTS
C2 RTS
C2 DTR
C2 DSR
AUTO TEST
R41 100K
U19 ACT14
U17 ACT08
U23 HC367
SSN
U3 TLC27M7
P5VDC
C23 .0uf
R11 1K
Q2 VN0206
C61 1000pf
R42 3.3K
R16 10K
R21 100K
R9 10K
U11 HC32
U20 ACT04
U5 74HC4060
R22 470K
R17 .25% 1/8W
182K
C25 .01uf
C29 .1uf 20%
TP1
TP2
C30 .1uf 20%
C6 10uf 10V
U16 ACT574
U13 ACT574
U15 ACT573
U12 ACT04
C59 .01
C48 1uf 20v
C49 100uf 10V
C50 .1 20%
5AC312 U25
SWITCHED BATTERY
WATCHDOG ENABLE
DEBUG COMM INTR
WATCHDOG MC1
WATCHDOG MC2
VPP SHUTDOWN
AUX COMM INTR
BACKLIGHT ENABLE
WAKE UP 1
WAKE UP 2
POWER ON KEY 1
WATCHDOG POWER OFF
AUTO POWER ON
PO STROBE
MASTER INTR 1
MASTER INTR 2
LED SYNC
RDN
WRN
BDB0
BDB1
BDB2
BDB3
BDB4
BDB5
BDB6
BDB7
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
GCS4
GCS5
SLAVE RXD 1
SLAVE TXD 1
SLAVE RXD 2
SLAVE TXD 2
P5VPROT
SLAVE WATCHDOG
-8VDC
SEGERROR DETECTED
PU1
PU2
R34 332K 1%
R33 100K 1%
U22
R50 100K
SSN
SLAVE RXD
SLAVE TXD
SLAVE SELECT
P12VF
P12VF TEST
R44 200K
C37 1uf 20V
R31 200K
C7 820pf 100V
U21 HC132
R30 2.2M
C28 .22uf 20%
R10 3.3M
1N4148 D3
Q4 VN2206
R39 10K
Q5 VN0206
C5 39uf +10V

SCHEMATIC, LOGIC BOARD
MODEL 1340/1 (PC-4XL)

EFFECTIVE JUNE 2000

SHEET 3 OF 3

Service Bulletin

Number 371A

Service Bulletins are supplements to IVAC technical service manuals.

Model(s) Affected: MedSystem III™ Multi-Channel Infusion Pump - Model 2860
Date: September 1995
Subject: Back-Up Battery Cable Adhered to Top Board

Purpose

The purpose of this bulletin is to provide Biomedical Technicians instructions and an explanation for adhering the back-up battery cable to the top board.

This bulletin supersedes Service Bulletin #371, to:

a. provide a method for identifying back-up battery cables that have been adhered to the top board, without having to remove the top board pad, and
b. reflect the inclusion of a top board pad in the back-up battery cable kit.

Explanation

The header pins protruding through the top board can puncture the back-up battery cable. The battery backed ram memory could be lost, causing watchdog 47,3. Cable damage failures are prevented by adhering the cable to the board.

References

2860 Series Technical Service Manual

Parts and Tools Required*

- Birch Stick with beveled ends
- Chem-Wipes
- Alcohol
- Loctite Tak Pak bonding Kit 216
  Adhesive/accelerator system. Adhesive is ethyl cyanoacrylate based. Accelerator is Freon TA based. Both are clear liquids.
- Back-Up Battery Cable Kit; IVAC P/N 2860737
  (Kit consists of a back-up battery cable, a top board pad, and this service bulletin.)

* These are in addition to parts, tools, and equipment referenced in the service manual.

Recommended Action

When replacing the back-up battery cable, disassemble the instrument, remove the existing back-up battery cable, and install the new battery cable per the Service Manual. Perform steps 7 through 12 of the following procedure.

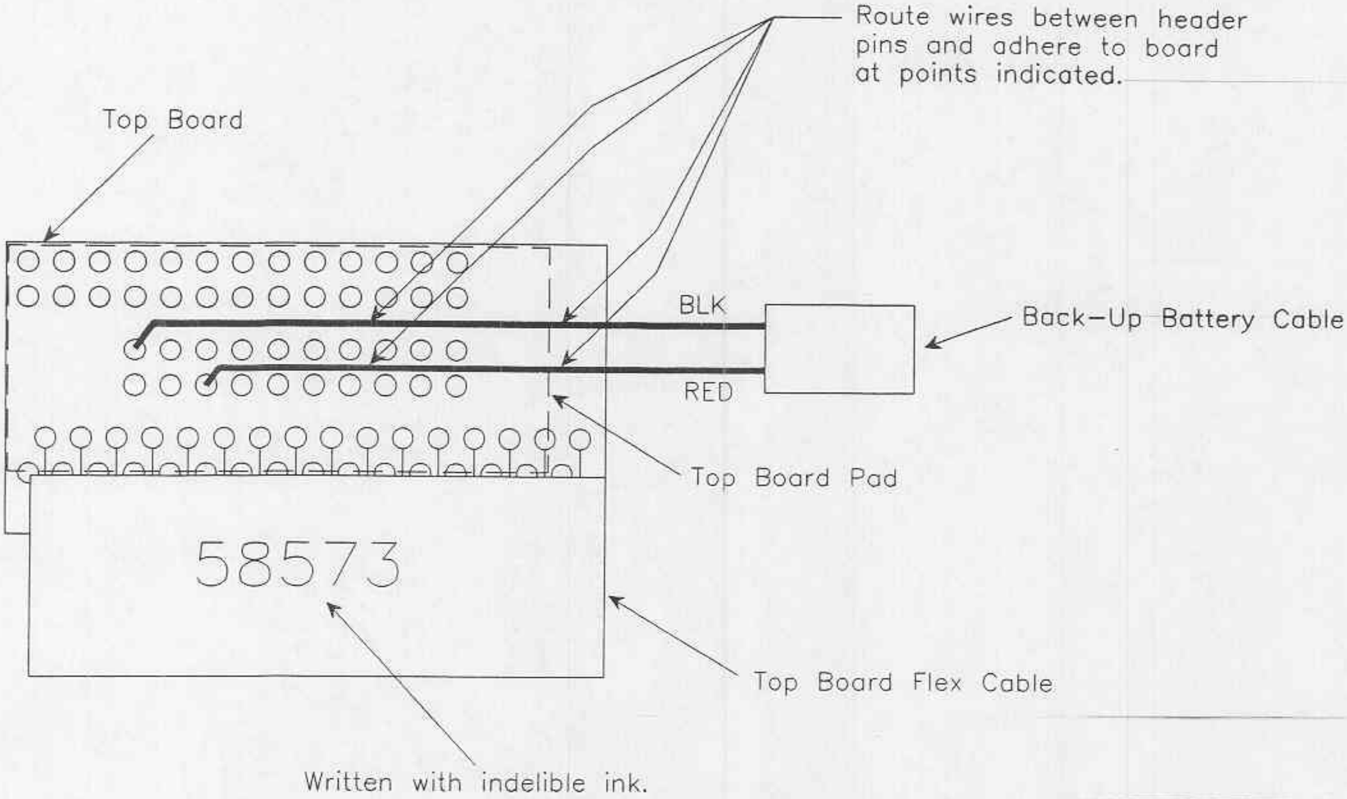
To determine if the back-up battery cable needs to be adhered to the top board, perform the following procedure.

1. Remove the battery cap cover by peeling the label off to reveal the hold down screws.
2. Remove the four corner screws and set aside the battery cap assembly.
3. Look for "58573" on the top board flex cable (*see Figure 1*).
    a. The presence of this number on the cable indicates that the back-up battery cable is already adhered in place or that header pins are not protruding through the top board. Proceed to step 12.
    b. If "58573" is not on the flex cable, proceed to the next step.
4. Remove the black foam tape (top board pad) carefully, so as not to damage the back-up battery cable.
5. Verify whether or not header pins are protruding through the top board.

    NOTE: If the header pins are protruding through the board they will be sharp to the touch.

    a. If header pins are not protruding, rework is not necessary. Proceed to step 10.
    b. If header pins are protruding, proceed to the next step.
6. Inspect the battery cable for header pin damage. If the cable is damaged, replace the back-up battery cable (*reference Repair chapter of Service Manual*).
7. Using alcohol and an acid brush clean the areas where the back-up battery cable is to be adhered (*see Figure 1*). Wipe the areas clean of any residue or debris.
8. Route the cable between the header pin rows. Apply Loctite 216 adhesive accelerator to the wire and board in the areas where the back-up battery cable is to be adhered (*see Figure 1*). Let the accelerator dry for two to three minutes.
9. Apply a small amount of Loctite 216 adhesive to the top board in the areas where the accelerator was applied, and hold the wire in place until the adhesive is set.
10. Apply a new top board pad to the top board, covering the header pin solder points.
11. Using indelible ink write "58573" on the top board flex cable (*see Figure 1*).
12. Reassemble and test (*reference appropriate sections of Service Manual*).

Figure 1 - *Back-Up Battery Cable Installation*


Route wires between header pins and adhere to board at points indicated.
Top Board
BLK
Back–Up Battery Cable
RED
Top Board Pad
58573
Top Board Flex Cable
Written with indelible ink.

IVAC®
CORPORATION

P/N 140972A

Service Bulletin

Number 378

Service Bulletins are supplements to IVAC technical service manuals.

Model Affected: IVAC MedSystem III Multi-Channel Infusion Pump, Model 286X
Date: April 1995
Subject: Battery Housing Replacement Procedure

Purpose

The purpose of this bulletin is to provide the following:

- **Troubleshooting tip** when the screws mounting the battery assembly will not tighten and/or the battery housing does not seat firmly against the main housing.
- Battery housing replacement procedure.

Explanation

A broken boss on the battery housing can prevent the housing from mounting securely to the main housing. A procedure, and the parts required, have been made available, to allow the battery housing to be replaced separate from the battery assembly.

References

Model 2860 Technical Service Manual

Parts and Tools Required*

- one (1) each - Battery Housing Kit ; IVAC P/N 2860530
  (Kit consists of: one battery housing, four O-rings, one battery cap label, five sealing screws, and this service bulletin.)
- As required - Dow Corning 739 Rubber Adhesive

* These are in addition to parts, tools, and equipment referenced in the service manual.

Recommended Action

If the screws mounting the battery assembly will not tighten, or the battery housing does not seat firmly against the main housing, use the following procedure and Figure 1 to:

- Inspect the mounting bosses inside the battery housing to ensure there are no cracks or breakage.
- Replace a cracked/broken battery housing.

Recommended Action (Cont'd.)

1. Remove the battery housing. To separate the battery and housing, which are held together with rubber adhesive:
    a. Grip and pull the battery harness while applying pressure against the housing, so as to push the housing away from the battery.
    b. Apply firm but steady force, to reduce the potential for damage to the harness or foil shield.
    c. When the housing and battery are separated enough to have broken the adhesive connection, gently remove the battery from the housing to avoid damage to the foil shield.

    NOTE: Replace the battery assembly if the foil shielding is torn.
2. Discard a cracked or broken battery housing and replace it with a new housing.
3. Reform the foil shield as necessary to ensure it is in its proper location around the battery cells.
4. Verify the battery harness is securely in place and that it is not damaged.

    NOTE: Replace the battery assembly if the harness is damaged.
5. Ensure one O-ring is positioned in each of the mounting hole locations in the base of the battery pack.

    NOTE: The battery housing kit contains O-rings, for use in the event any of the original O-rings were lost during disassembly of the battery assembly.
6. Apply Dow Corning 739 rubber adhesive to the top portion of the foil shield, to hold the battery housing in place.
7. Place the battery pack into the battery housing.
8. Reinstall the battery assembly. (*Reference Battery Pack Reassembly section of Repair chapter in Service Manual.*)
9. Complete the assembly and test per the service manual and current procedures.

Recommended Action (Cont'd.)

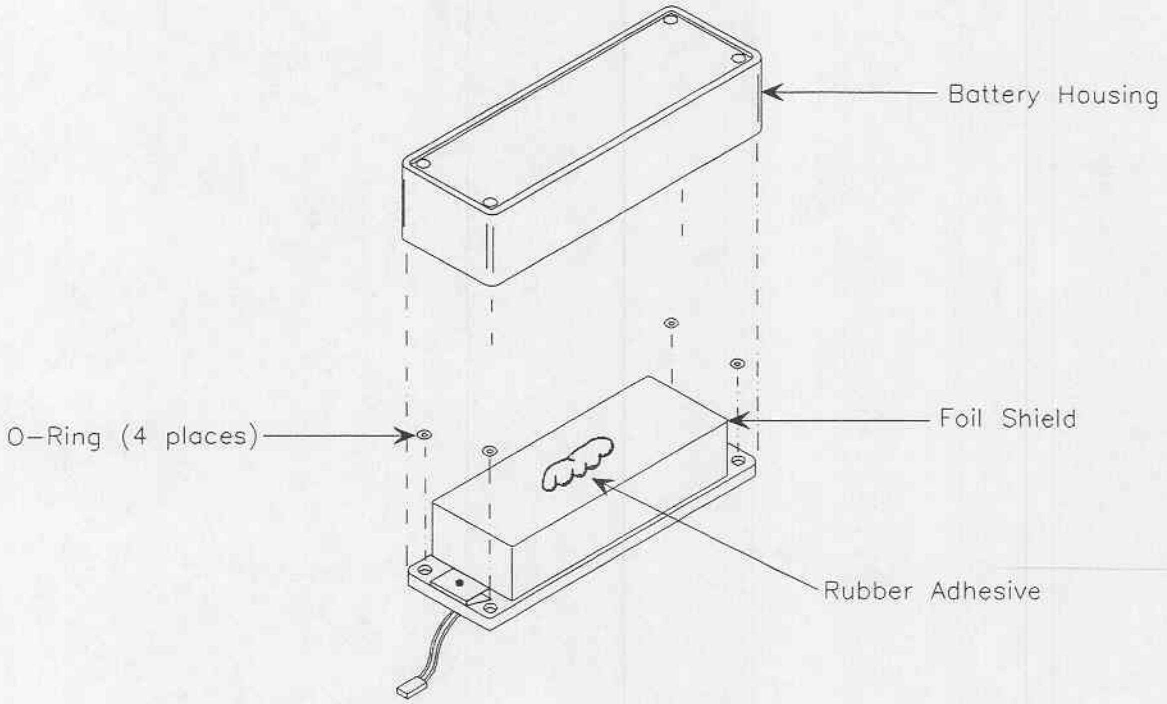

Battery Housing
Foil Shield
O-Ring (4 places)
Rubber Adhesive

Figure 1 *- Battery Assembly*

IVAC™
MEDICAL SYSTEMS

IVAC Instrument Production:
9190 Activity Road, San Diego, CA 92126 U.S.A.
P.O. Box 85335, San Diego, CA 92186-5335

Service Bulletin 391

P/N 136469A

Service Bulletins are supplements to IVAC technical service manuals.

Model Affected: MedSystem III™ Multi-Channel Infusion Pump - Model 2863
Date: March 1996
Subject: Logic Board Assembly Enhancement

Purpose

The purpose of this bulletin is to provide Biomedical Technicians an updated logic board schematic for the Model 2863, which reflects various changes estimated to be incorporated into instruments being built by April 1, 1996. This is *reference information only* and is not intended to suggest a need for component changes.

Explanation

The logic board assembly (previously referred to as the main electronics assembly) has been enhanced, as follows:

1. The LCD display brightness has been improved by making the following changes to the LCD contrast resistors.

COMPONENT	FROM	TO
R12	0Ω	8.2K, 5%
R13	7.5K, 5%	150Ω, 5%

2. The potential for nuisance watchdog 31,3 alarms, in instruments with Rev. 4.0 software, has been reduced by making the following component changes in the watchdog circuit.

COMPONENT	FROM	TO
R46	12K, 5%	12.7K, 1%
C33	.001µF, 10%	1000pF, 5%

3. The following component changes have been made, due to the previously used version of the IC no longer being available.

COMPONENT	FROM	TO
U30	TI	National
R42	1K, 5%	1Ω, 5%

Explanation (Cont'd.)

NOTE: The same TI part has also been used on the Model 2860 SMT Board Assembly, as U34. If U34 is replaced with a National part, R138 (1K) would be replaced with a 1Ω resistor.

4. U40 and C45-C48 have been removed due to being part of a circuit that is not in use.
5. The need for jumper wire has been eliminated, and as a result C49 has been updated from a leaded to a surface mount component.

References

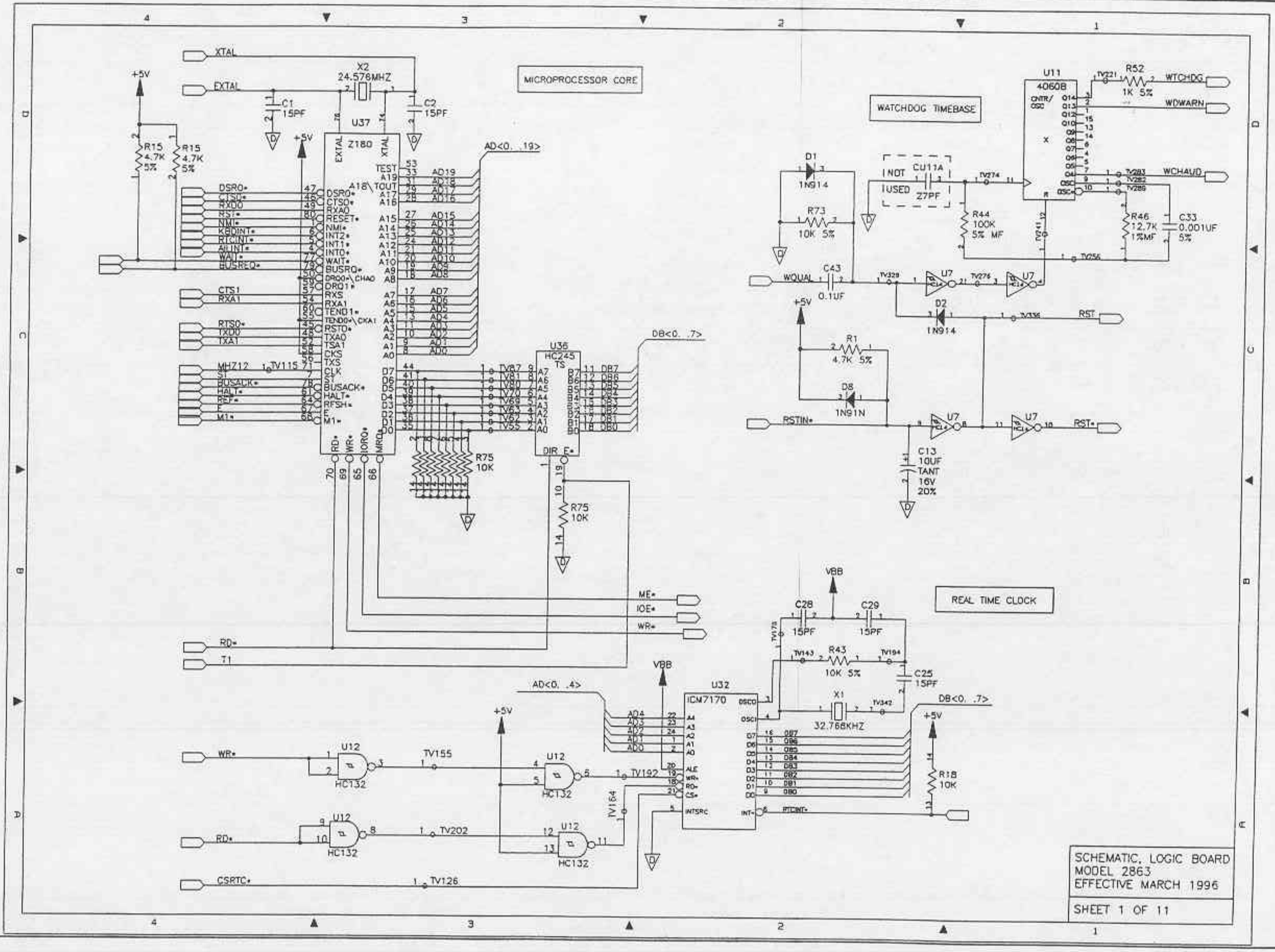
2860 Series Technical Service Manual

Parts and Tools Required

Not applicable.

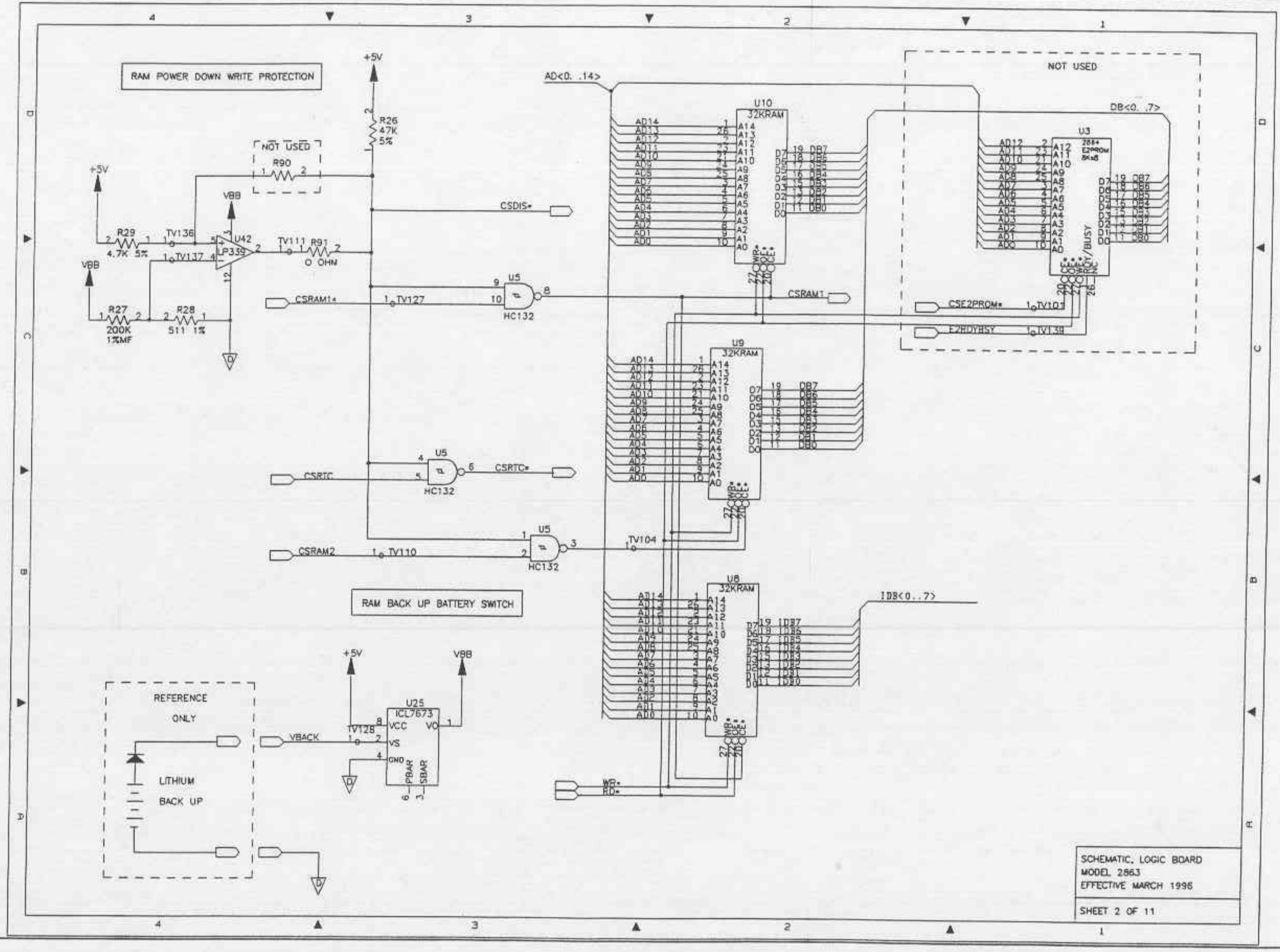
Recommended Action

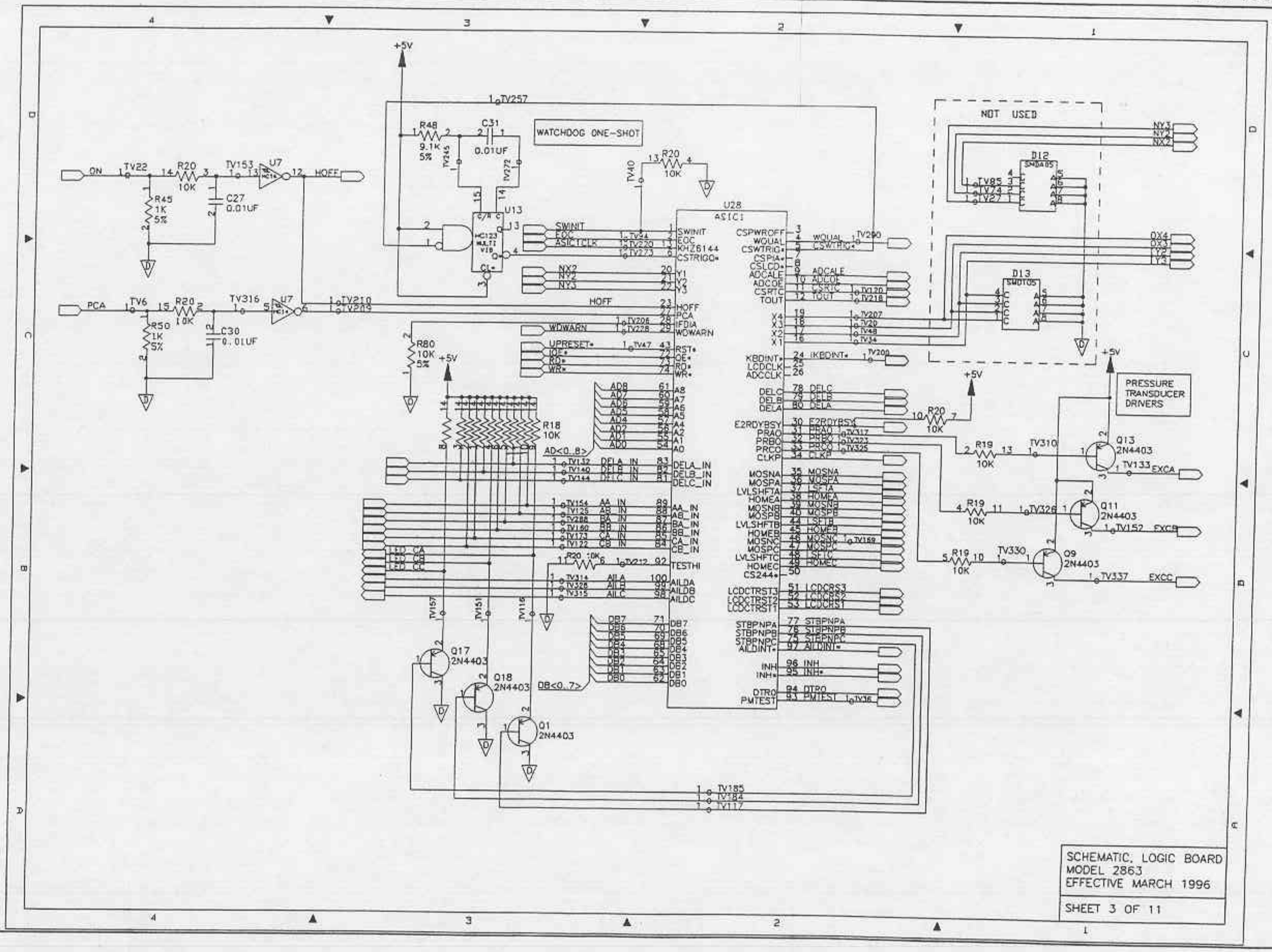
Keep the schematic references current by adding this bulletin to the 2860 Series service manual.


MICROPROCESSOR CORE
WATCHDOG TIMEBASE
REAL TIME CLOCK
XTAL
EXTAL
X2
24.576MHZ
C1
15PF
C2
15PF
+5V
R15
4.7K
5%
U37
Z180
AD<0..19>
DSRO•
CTSO•
RXDO
RST•
NMI•
KBDINT•
RTCINT•
AUINT•
WAIT•
BUSREQ•
CTS1
RXA1
RTSO•
TXDO
TXA1
MHZ12
TV115
ST
BUSACK•
HALT•
RFSH•
E
M1•
RD•
WR•
IORQ•
MRQ•
U36
HC245
TS
DB<0..7>
R75
10K
DIR E•
ME•
IOE•
T1
U11
4060B
CNTR/OSC
WTCHDG
WDWARN
WCHAUD
R52
1K 5%
D1
1N914
R73
10K 5%
CU11A
NOT USED
27PF
R44
100K
5% MF
R46
12.7K
1%MF
C33
0.001UF
5%
WQUAL
C43
0.1UF
U7
D2
1N914
RST
R1
4.7K 5%
D8
1N91N
RSTIN•
RST•
C13
10UF
TANT
16V
20%
VBB
C28
15PF
C29
15PF
R43
10K 5%
C25
15PF
X1
32.768KHZ
U32
ICM7170
AD<0..4>
R18
10K
PTCINT•
INTSRC
U12
HC132
TV155
TV192
TV164
TV202
TV126
CSRTC•
D C B A
4 3 2 1

SCHEMATIC, LOGIC BOARD
MODEL 2863
EFFECTIVE MARCH 1996

SHEET 1 OF 11


RAM POWER DOWN WRITE PROTECTION
NOT USED
R90
R26 47K 5%
+5V
VBB
R29 4.7K 5%
R27 200K 1%MF
R28 511 1%
U42 LP339
TV136
TV137
TV111
R91 0 OHM
CSDIS*
CSRAM1*
TV127
U5 HC132
CSRAM1
CSRTC
CSRTC*
CSRAM2
TV110
TV104
RAM BACK UP BATTERY SWITCH
AD<0..14>
U10 32KRAM
U9 32KRAM
U8 32KRAM
U3 28C64 E2PROM 8Kx8
DB<0..7>
IDB<0..7>
CSE2PROM*
E2RDYBSY
TV101
TV139
RDY/BUSY
WR*
RD*
REFERENCE ONLY
LITHIUM BACK UP
VBACK
TV128
U25 ICL7673
VCC
VS
GND
VO
PBAR
SBAR
SCHEMATIC, LOGIC BOARD
MODEL 2863
EFFECTIVE MARCH 1996
SHEET 2 OF 11


WATCHDOG ONE-SHOT
NOT USED
PRESSURE TRANSDUCER DRIVERS
U28
ASIC1
U13
U7
D12
D13
Q13 2N4403
Q11 2N4403
Q9 2N4403
Q17 2N4403
Q18 2N4403
Q1 2N4403
R48 9.1K 5%
C31 0.01UF
R20 10K
R45 1K 5%
C27 0.01UF
R50 1K 5%
C30 0.01UF
R80 10K 5%
R18 10K
R19 10K
+5V
ON
PCA
HOFF
SWINIT
EOC
ASICICLK
NY2
NX2
NY3
WDWARN
UPRESET*
IOE*
RD*
WR*
AD<0..8>
DB<0..7>
DELA_IN
DELB_IN
DELC_IN
AA_IN
AB_IN
BA_IN
BB_IN
CA_IN
CB_IN
LED CA
LED CB
LED CC
TESTHI
AILA
AILB
AILC
CSPWROFF
WOUAL
CSWTRIG*
ADCALE
ADCOE
CSRTC
TOUT
KBDINT*
DELC
DELB
DELA
E2RDYBSY
PRAO
PRBO
PRCO
CLKP
MOSNA
MOSPA
LVLSHFTA
HOMEA
LCDCRST3
LCDCRST2
LCDCRST1
STBPNPA
STBPNPB
STBPNPC
AILDINT*
INH
INH*
DTRO
PMTEST
NY3
NY2
NX2
DX4
DX3
YY2
YY3
EXCA
EXCB
EXCC
TV185
TV184
TV117

SCHEMATIC, LOGIC BOARD
MODEL 2863
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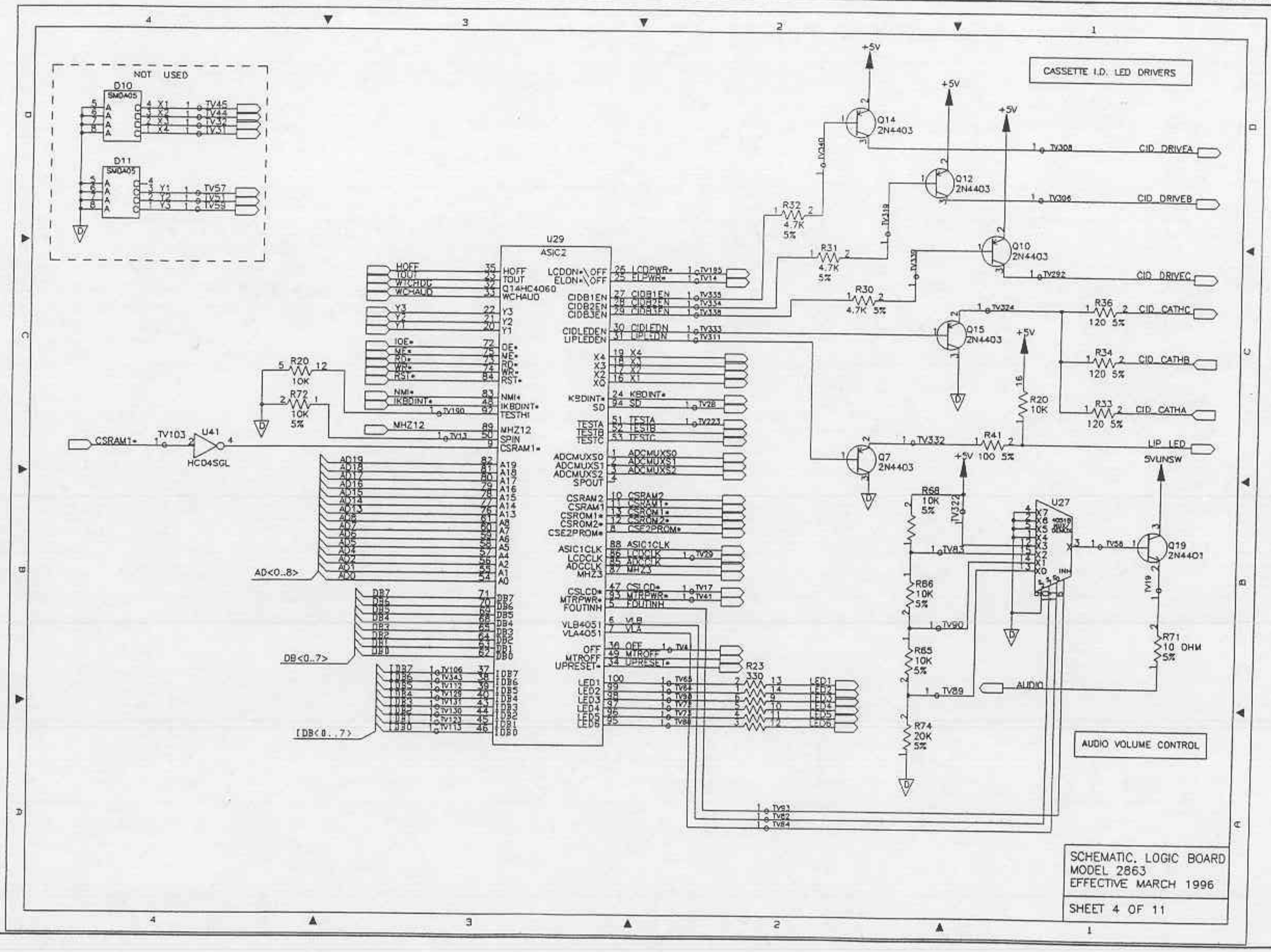
CASSETTE I.D. LED DRIVERS
AUDIO VOLUME CONTROL
NOT USED
D10
SMDA05
D11
U29
ASIC2
U27
U41
HC04SGL
Q14 2N4403
Q12 2N4403
Q10 2N4403
Q15 2N4403
Q7 2N4403
Q19 2N4401
R32 4.7K 5%
R31 4.7K 5%
R30 4.7K 5%
R36 120 5%
R34 120 5%
R33 120 5%
R20 10K
R41 100 5%
R68 10K 5%
R66 10K 5%
R65 10K 5%
R74 20K 5%
R71 10 OHM 5%
R72 10K 5%
R23 330
+5V
CID_DRIVEA
CID_DRIVEB
CID_DRIVEC
CID_CATHC
CID_CATHB
CID_CATHA
LIP_LED
5VUNSW
AUDIO
CSRAM1*
MHZ12
AD<0..8>
DB<0..7>
IDB<0..7>
LED1
LED2
LED3
LED4
LED5
LED6

SCHEMATIC, LOGIC BOARD
MODEL 2863
EFFECTIVE MARCH 1996

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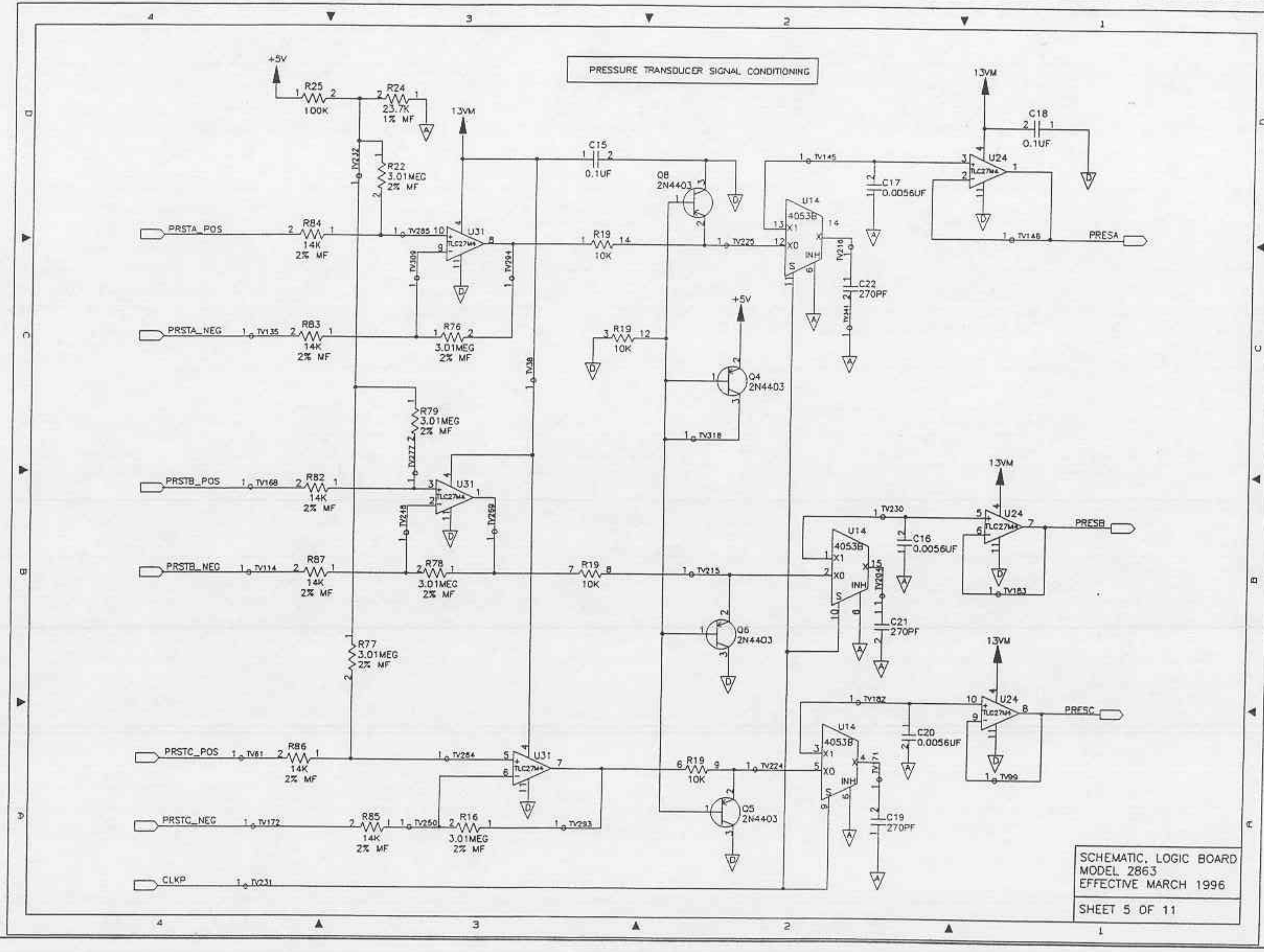
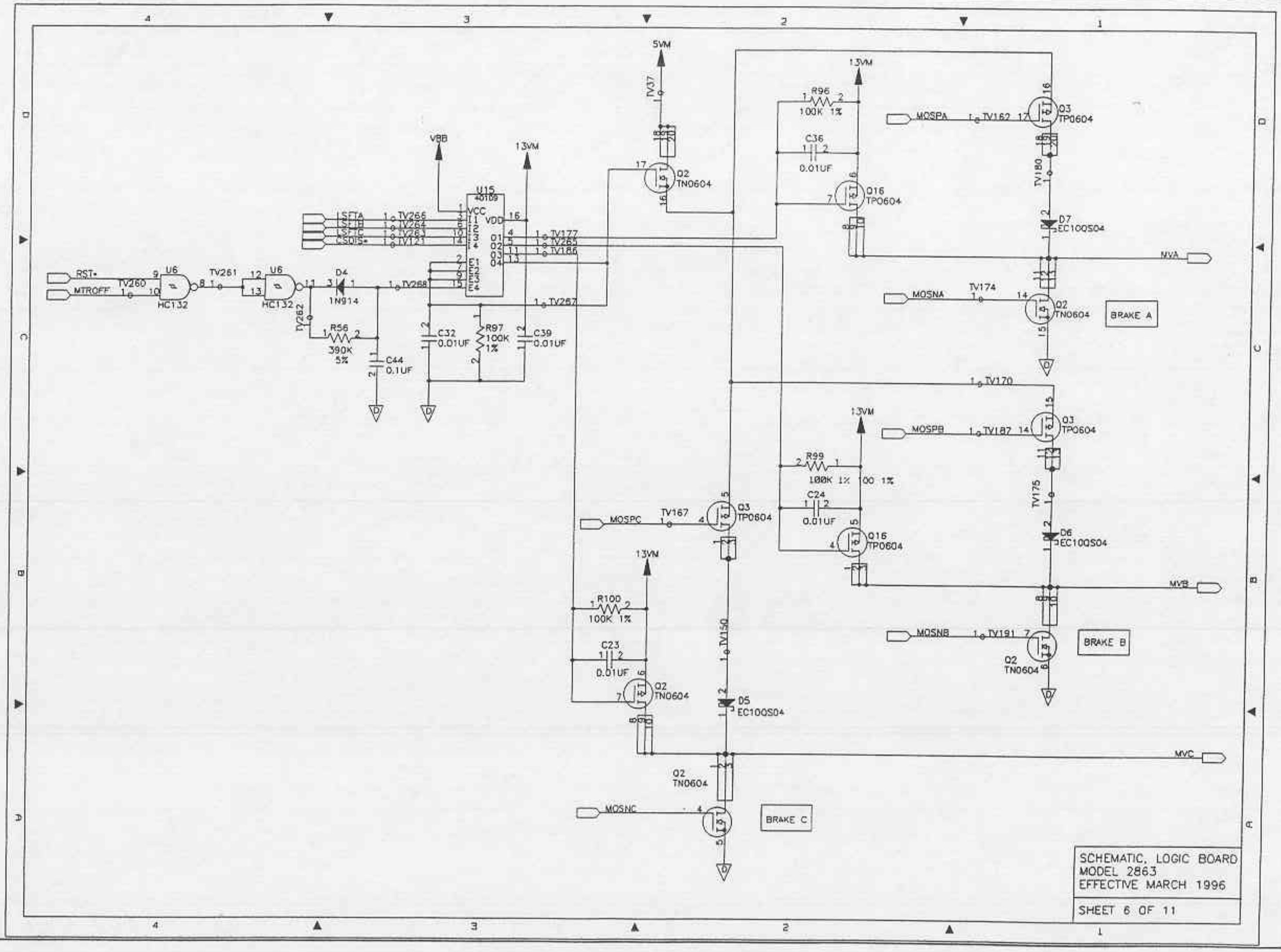

PRESSURE TRANSDUCER SIGNAL CONDITIONING
PRSTA_POS
PRSTA_NEG
PRSTB_POS
PRSTB_NEG
PRSTC_POS
PRSTC_NEG
CLKP
PRESA
PRESB
PRESC
+5V
13VM
R25 100K
R24 23.7K 1% MF
R22 3.01MEG 2% MF
R84 14K 2% MF
R83 14K 2% MF
R76 3.01MEG 2% MF
R79 3.01MEG 2% MF
R82 14K 2% MF
R87 14K 2% MF
R78 3.01MEG 2% MF
R77 3.01MEG 2% MF
R86 14K 2% MF
R85 14K 2% MF
R16 3.01MEG 2% MF
R19 10K
C15 0.1UF
C18 0.1UF
C17 0.0056UF
C16 0.0056UF
C20 0.0056UF
C22 270PF
C21 270PF
C19 270PF
Q8 2N4403
Q4 2N4403
Q6 2N4403
Q5 2N4403
U31 TLC27M4
U24 TLC27M4
U14 4053B
X1
X0
X
INH
S
TV232
TV285
TV309
TV294
TV135
TV38
TV277
TV168
TV248
TV259
TV114
TV61
TV284
TV172
TV250
TV293
TV231
TV225
TV318
TV215
TV224
TV145
TV216
TV141
TV146
TV230
TV204
TV183
TV182
TV71
TV99
A
B
C
D
1
2
3
4

SCHEMATIC, LOGIC BOARD
MODEL 2863
EFFECTIVE MARCH 1996

SHEET 5 OF 11


RST•
MTROFF
TV260
U6
HC132
TV261
U6
HC132
D4
1N914
TV262
R56
390K
5%
C44
0.1UF
TV268
LSFTA
LSFTB
LSFTC
CSDIS•
TV266
TV264
TV263
TV121
VBB
13VM
U15
40109
VCC
VDD
I1
I2
I3
I4
E1
E2
E3
E4
O1
O2
O3
O4
TV177
TV265
TV186
TV267
C32
0.01UF
R97
100K
1%
C39
0.01UF
5VM
TV37
Q2
TN0604
13VM
R96
100K 1%
C36
0.01UF
Q16
TP0604
MOSPA
TV162
Q3
TP0604
TV180
D7
EC10QS04
MVA
MOSNA
TV174
Q2
TN0604
BRAKE A
TV170
13VM
MOSPB
TV187
Q3
TP0604
R99
100K 1%
100 1%
C24
0.01UF
Q16
TP0604
TV175
D6
EC10QS04
MVB
MOSNB
TV191
Q2
TN0604
BRAKE B
MOSPC
TV167
Q3
TP0604
13VM
R100
100K 1%
C23
0.01UF
Q2
TN0604
TV150
D5
EC10QS04
MVC
Q2
TN0604
MOSNC
BRAKE C
A
B
C
D
1
2
3
4

SCHEMATIC, LOGIC BOARD
MODEL 2863
EFFECTIVE MARCH 1996

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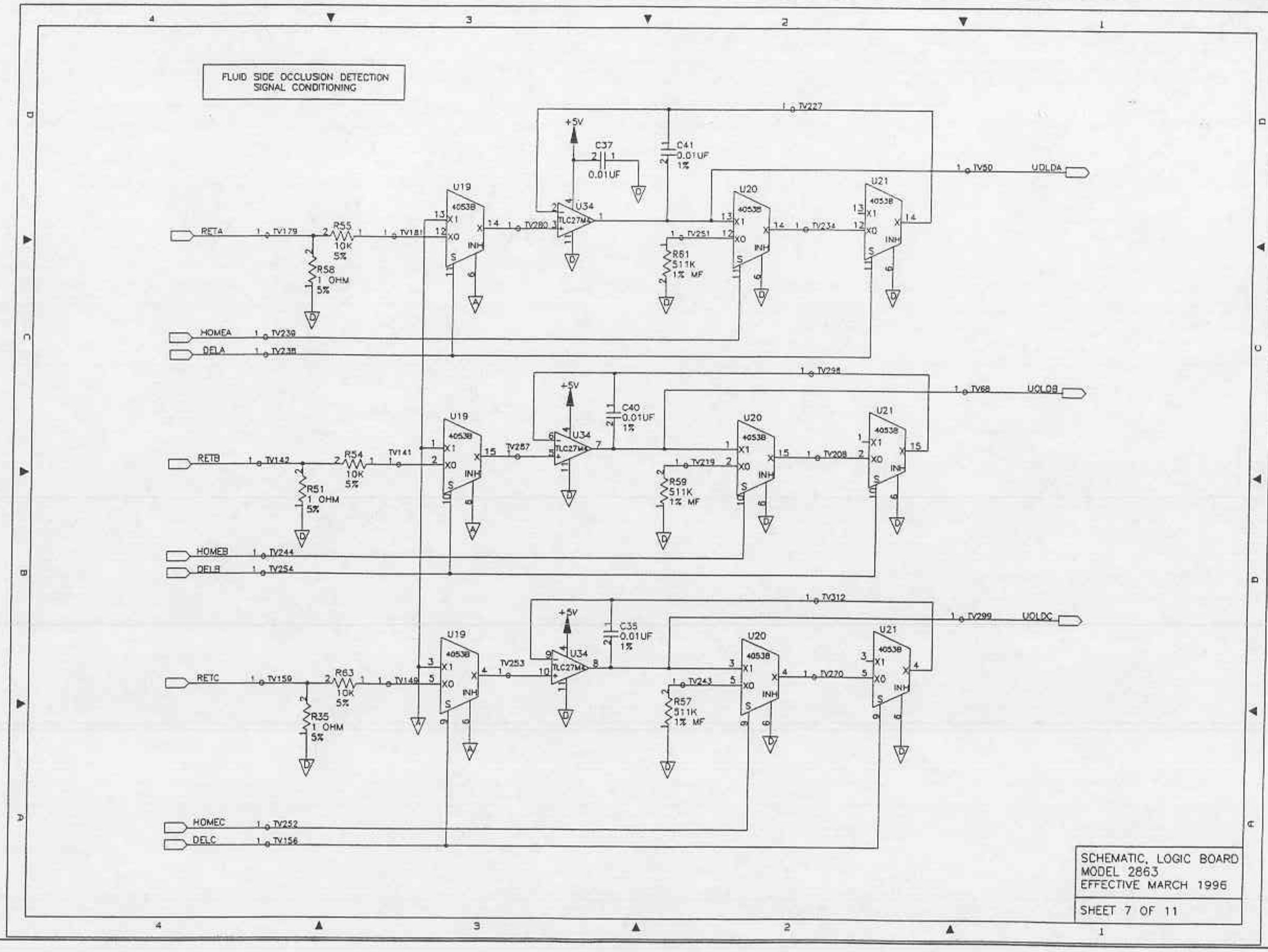
FLUID SIDE OCCLUSION DETECTION
SIGNAL CONDITIONING
RETA
TV179
R55
10K
5%
R58
1 OHM
5%
TV181
U19
4053B
X1
X0
X
INH
S
TV280
U34
TLC27M4
+5V
C37
0.01UF
C41
0.01UF
1%
TV227
TV251
R61
511K
1% MF
U20
4053B
TV234
U21
4053B
TV50
UOLDA
HOMEA
TV239
DELA
TV238
TV298
TV68
UOLDB
RETB
TV142
R54
10K
5%
R51
1 OHM
5%
TV141
TV287
C40
0.01UF
1%
TV219
R59
511K
1% MF
TV208
HOMEB
TV244
DELB
TV254
TV312
TV299
UOLDC
RETC
TV159
R63
10K
5%
R35
1 OHM
5%
TV149
TV253
C35
0.01UF
1%
TV243
R57
511K
1% MF
TV270
HOMEC
TV252
DELC
TV156
A
B
C
D
1
2
3
4

SCHEMATIC, LOGIC BOARD
MODEL 2863
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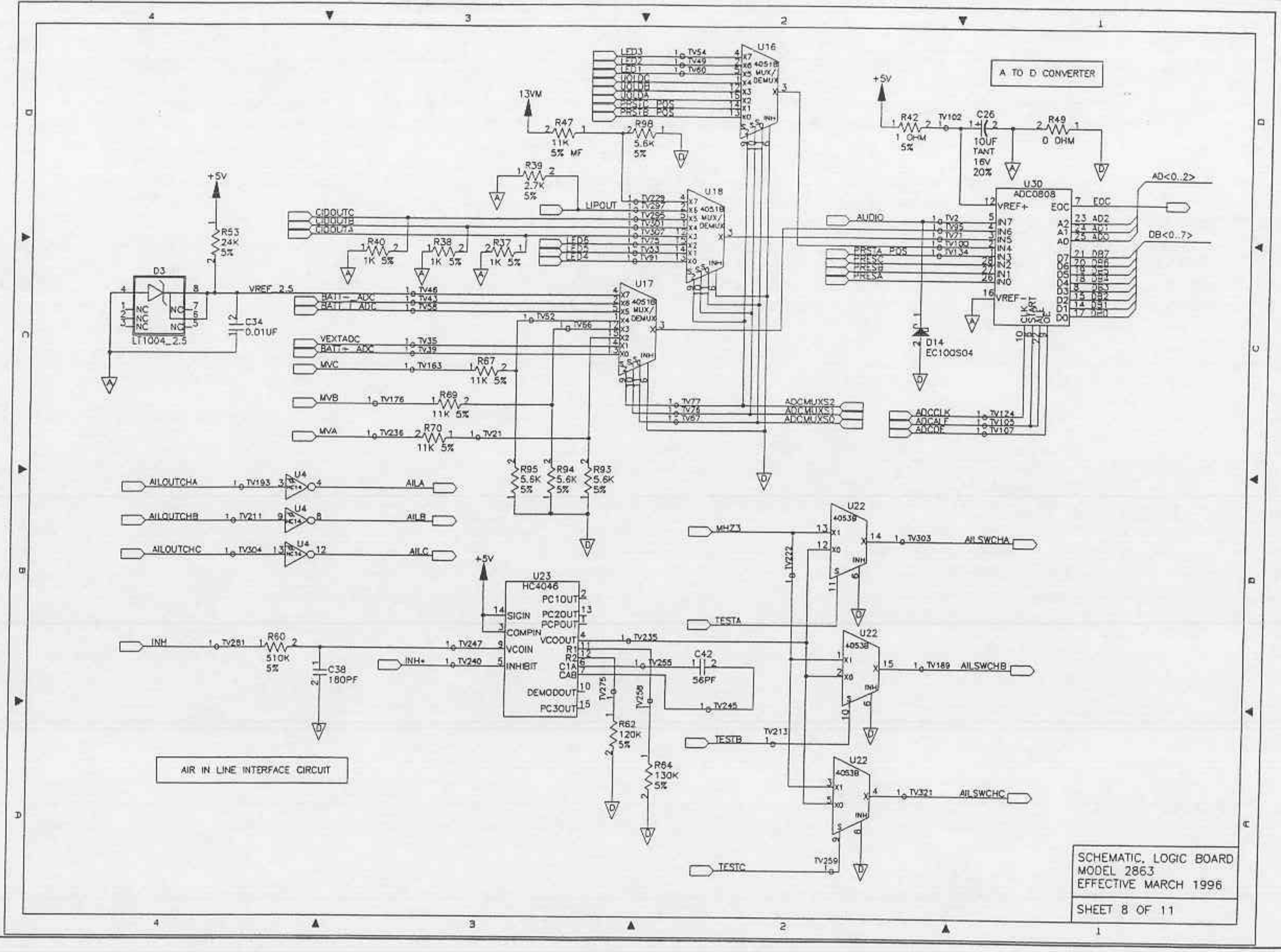
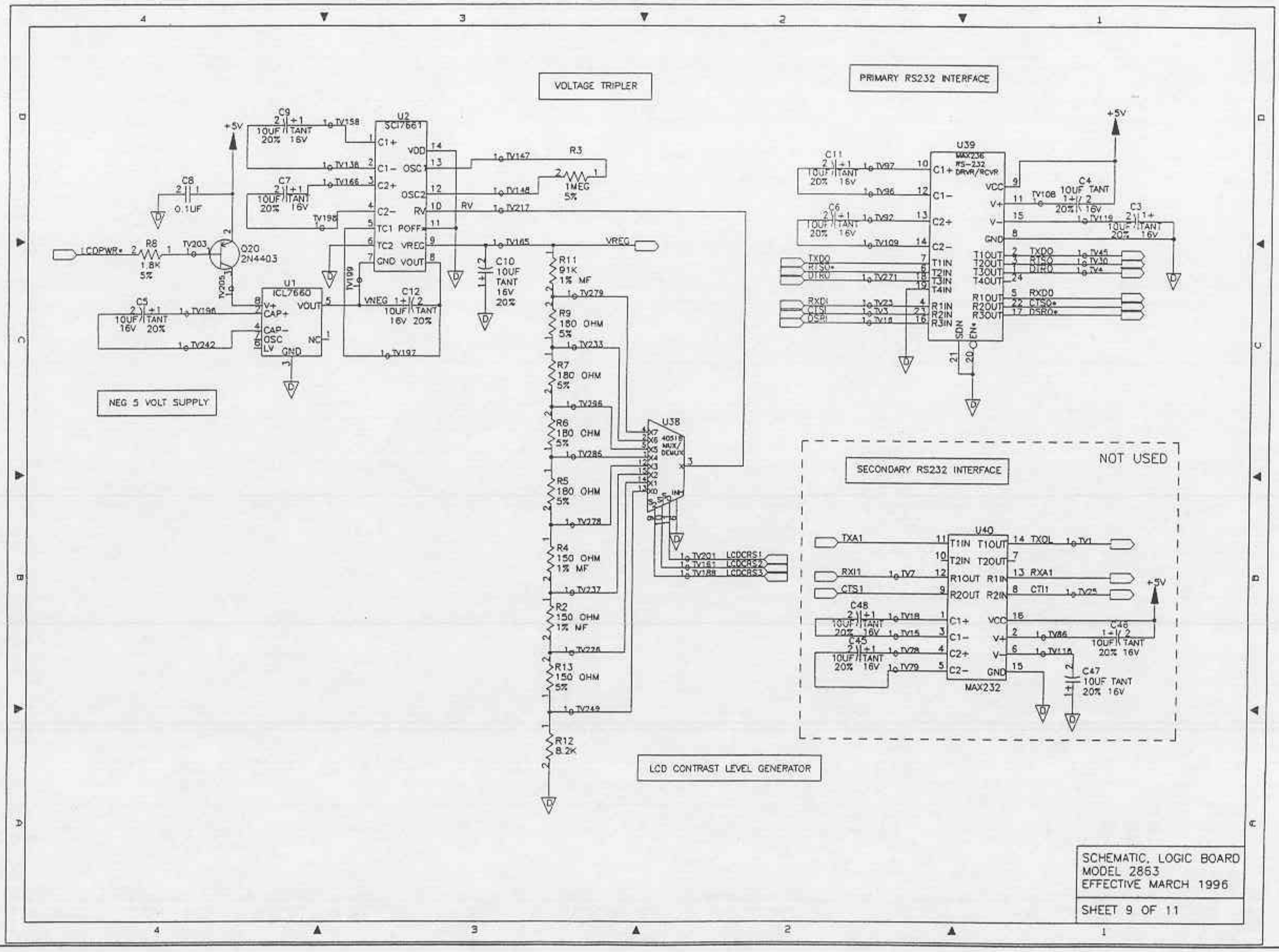
SHEET 7 OF 11


A TO D CONVERTER
U30
ADC0808
VREF+
VREF-
EOC
AD<0..2>
DB<0..7>
ADCCLK
ADCALE
ADCOE
AUDIO
PRSTA POS
PRESC
PRESB
PRESA
D14
EC10QS04
R42
1 OHM
5%
C26
10UF
TANT
16V
20%
R49
0 OHM
+5V
13VM
U16
U17
U18
4051B
MUX/
DEMUX
LED3
LED2
LED1
IOOLDC
IOOLDB
IOOLDA
PRSTC POS
PRSTB POS
R47
11K
5% MF
R98
5.6K
5%
R39
2.7K
5%
LIPOUT
CIDOUTC
CIDOUTB
CIDOUTA
R40
R38
R37
1K 5%
LED5
LED6
LED4
D3
LT1004_2.5
VREF 2.5
R53
24K
5%
C34
0.01UF
BATT- ADC
BATT ADC
VEXTADC
BATT+ ADC
MVC
MVB
MVA
R67
R69
R70
11K 5%
R95
R94
R93
5.6K
5%
ADCMUXS2
ADCMUXS1
ADCMUXS0
AILOUTCHA
AILOUTCHB
AILOUTCHC
U4
AILA
AILB
AILC
INH
R60
510K
5%
C38
180PF
INH+
U23
HC4046
SIGIN
COMPIN
VCOIN
INHIBIT
PC1OUT
PC2OUT
PCPOUT
VCOOUT
R1
R2
C1A
CAB
DEMODOUT
PC3OUT
C42
56PF
R62
120K
5%
R64
130K
5%
MHZ3
TESTA
TESTB
TESTC
U22
4053B
AILSWCHA
AILSWCHB
AILSWCHC
AIR IN LINE INTERFACE CIRCUIT
SCHEMATIC, LOGIC BOARD
MODEL 2863
EFFECTIVE MARCH 1996
SHEET 8 OF 11


VOLTAGE TRIPLER
PRIMARY RS232 INTERFACE
NEG 5 VOLT SUPPLY
LCD CONTRAST LEVEL GENERATOR
SECONDARY RS232 INTERFACE
NOT USED
U2 SCI7661
U1 ICL7660
U38 4051B MUX/DEMUX
U39 MAX236 RS-232 DRVR/RCVR
U40 MAX232
Q20 2N4403
R8 1.8K 5%
R3 1MEG 5%
R11 91K 1% MF
R9 180 OHM 5%
R7 180 OHM 5%
R6 180 OHM 5%
R5 180 OHM 5%
R4 150 OHM 1% MF
R2 150 OHM 1% MF
R13 150 OHM 5%
R12 8.2K
C8 0.1UF
C10 10UF TANT 16V 20%
+5V
LCDPWR*
VREG
LCDCRS1
LCDCRS2
LCDCRS3
TXDO
RTSO*
DTRO
RXDI
CTSI
DSRI
TXA1
RXI1
CTS1
TXOL
RXA1
CTI1

SCHEMATIC, LOGIC BOARD
MODEL 2863
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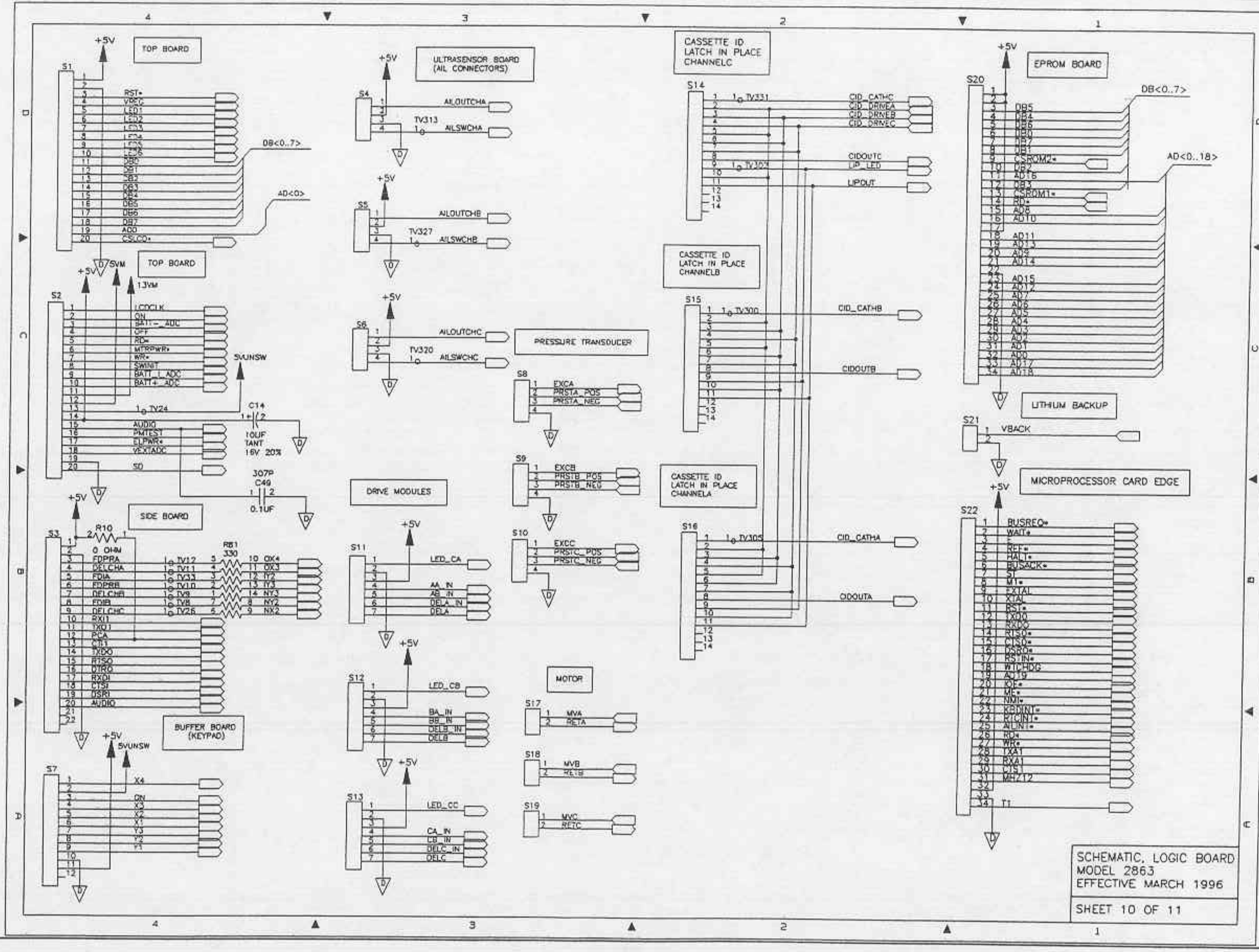
TOP BOARD
S1
DB<0..7>
AD<0>
TOP BOARD
S2
5VUNSW
C14
10UF TANT 16V 20%
307P C49 0.1UF
SIDE BOARD
S3
R10 0 OHM
RB1 330
BUFFER BOARD (KEYPAD)
S7
ULTRASENSOR BOARD (AIL CONNECTORS)
S4
AILOUTCHA
AILSWCHA
TV313
S5
AILOUTCHB
AILSWCHB
TV327
S6
AILOUTCHC
AILSWCHC
TV320
DRIVE MODULES
S11
LED_CA
S12
LED_CB
S13
LED_CC
PRESSURE TRANSDUCER
S8
S9
S10
MOTOR
S17
S18
S19
CASSETTE ID LATCH IN PLACE CHANNELC
S14
CASSETTE ID LATCH IN PLACE CHANNELB
S15
CASSETTE ID LATCH IN PLACE CHANNELA
S16
CID_CATHC
CID_CATHB
CID_CATHA
CIDOUTC
CIDOUTB
CIDOUTA
EPROM BOARD
S20
DB<0..7>
AD<0..18>
LITHIUM BACKUP
S21
VBACK
MICROPROCESSOR CARD EDGE
S22
+5V

SCHEMATIC, LOGIC BOARD
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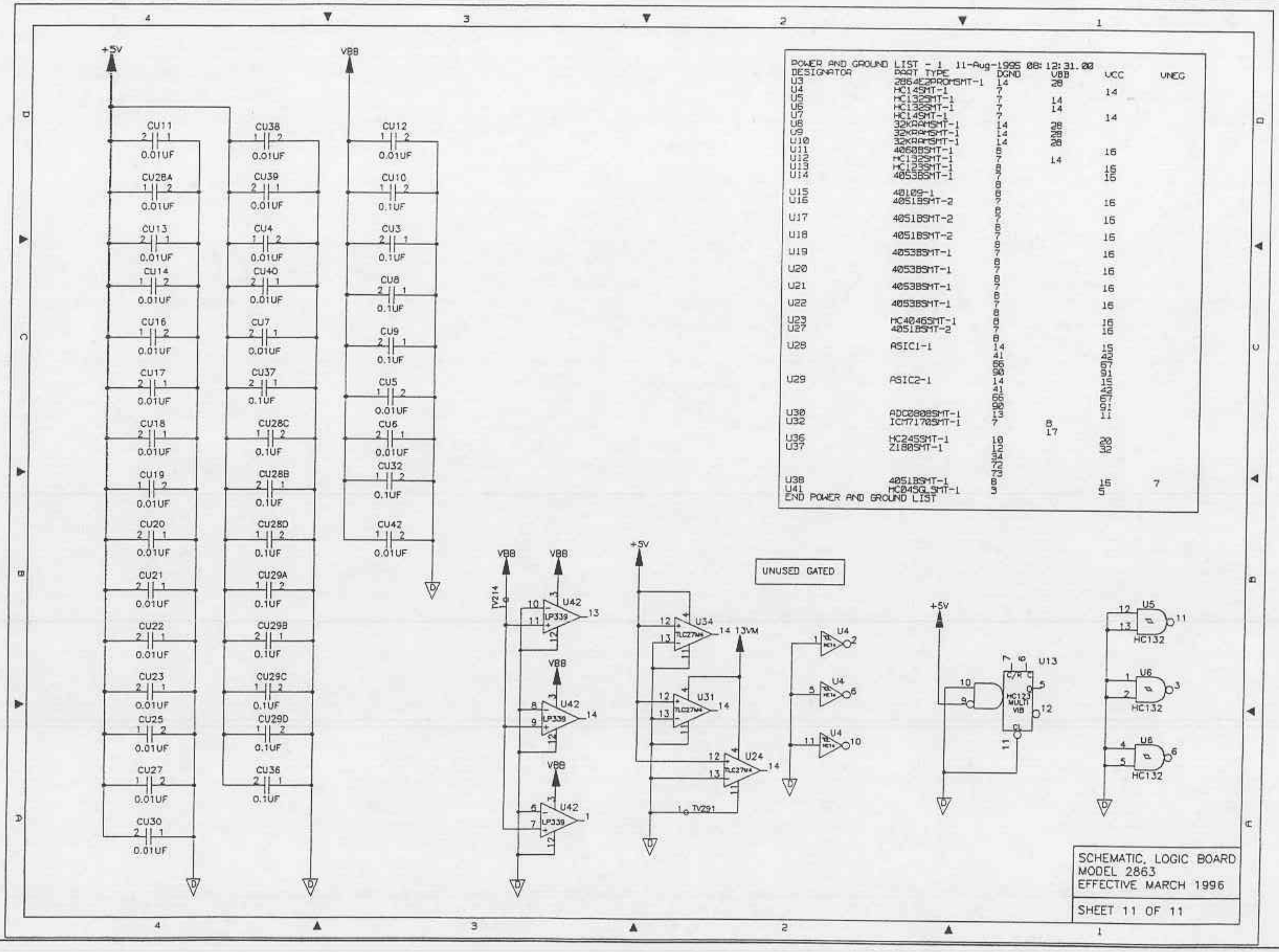
4
3
2
1
D
C
B
A
+5V
VBB
CU11 0.01UF
CU28A 0.01UF
CU13 0.01UF
CU14 0.01UF
CU16 0.01UF
CU17 0.01UF
CU18 0.01UF
CU19 0.01UF
CU20 0.01UF
CU21 0.01UF
CU22 0.01UF
CU23 0.01UF
CU25 0.01UF
CU27 0.01UF
CU30 0.01UF
CU38 0.01UF
CU39 0.01UF
CU4 0.01UF
CU40 0.01UF
CU7 0.01UF
CU37 0.1UF
CU28C 0.1UF
CU28B 0.1UF
CU28D 0.1UF
CU29A 0.1UF
CU29B 0.1UF
CU29C 0.1UF
CU29D 0.1UF
CU36 0.1UF
CU12 0.01UF
CU10 0.1UF
CU3 0.1UF
CU8 0.1UF
CU9 0.1UF
CU5 0.01UF
CU6 0.01UF
CU32 0.1UF
CU42 0.01UF
D
TV214
U42 LP339
U34 TLC27M4
U31 TLC27M4
U24 TLC27M4
13VM
TV291
UNUSED GATED
U4 HC14
U13 HC123 MULTI VIB C/R C CL
U5 HC132
U6 HC132
U8 HC132

```
POWER AND GROUND LIST - 1  11-Aug-1995 08:12:31.00
DESIGNATOR      PART TYPE         DGND   VBB    VCC     VNEG
U3              2864E2PROMSMT-1   14     28
U4              HC14SMT-1         7             14
U5              HC132SMT-1        7      14
U6              HC132SMT-1        7      14
U7              HC14SMT-1         7             14
U8              32KRAMSMT-1       14     28
U9              32KRAMSMT-1       14     28
U10             32KRAMSMT-1       14     28
U11             4060BSMT-1        8             16
U12             HC132SMT-1        7      14
U13             HC123SMT-1        8             16
U14             4053BSMT-1        7             16
                                  8
U15             40109-1           8
U16             4051BSMT-2        7             16
                                  8
U17             4051BSMT-2        7             16
                                  8
U18             4051BSMT-2        7             16
                                  8
U19             4053BSMT-1        7             16
                                  8
U20             4053BSMT-1        7             16
                                  8
U21             4053BSMT-1        7             16
                                  8
U22             4053BSMT-1        7             16
                                  8
U23             HC4046SMT-1       8             16
U27             4051BSMT-2        7             16
                                  8
U28             ASIC1-1           14            15
                                  41            42
                                  66            67
                                  90            91
U29             ASIC2-1           14            15
                                  41            42
                                  66            67
                                  90            91
U30             ADC0808SMT-1      13            11
U32             ICM7170SMT-1      7      8
                                         17
U36             HC245SMT-1        10            20
U37             Z180SMT-1         12            32
                                  34
                                  72
                                  73
U38             4051BSMT-1        8             15      7
U41             HC045GLSMT-1      3             5
END POWER AND GROUND LIST
```

SCHEMATIC, LOGIC BOARD
MODEL 2863
EFFECTIVE MARCH 1996

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ALARIS™
Medical Systems

10221 Wateridge Circle
San Diego, CA 92121, U.S.A.
P.O. Box 85335, San Diego, CA 92186-5335

Service Bulletin 394A

P/N 141942A

Service Bulletins are supplements to ALARIS Medical's Technical Service/Maintenance Manuals.

Models Affected: MedSystem III™ Multi-Channel Infusion Pump, Model 286X
Date: June 1997
Subject: Cleaning Procedure

☞ *This supersedes Service Bulletin 394, to reflect the following changes:*

- *The cleaning solution may include up to 10% bleach (instead of 3%), for use only on the instrument exterior.*
- *The cleaning solution may be sprayed (from a spray bottle) into the pumping mechanism area to help dissolve residue.*

Purpose

The purpose of this bulletin is to provide detailed information on the proper method for cleaning the instrument. The procedure outlined in this service bulletin replaces the cleaning procedures described in Service Bulletins 364 and 394, Cleaning Instructions 139405, and the Maintenance chapter of Technical Service Manual 139981.

Explanation

Organic solvents, ammonia, ammonium-based agents, isopropyl alcohol, and/or abrasive solutions are not acceptable cleaning agents. The use of up to 10% bleach in the cleaning solution is acceptable only when cleaning the instrument exterior.

The process of "spraying" a cleaning solution into the pumping mechanism area is acceptable, to help dissolve residue that is difficult to remove or in hard to reach areas.

Using pressurized air to dry the mechanism area can cause damage.

References

Model 2860/2863 Technical Service Manual

Parts and Tools Required

Reference the service manual assembly, if servicing becomes necessary.

Recommended Action

The steps which follow should be used to keep the instrument clean.

Cleaning Procedure

***WARNING*:**

To avoid electrical hazard, always disconnect AC adapter power cord from the wall outlet before cleaning the instrument.

***CAUTIONS*:**

- *Do not clean the instrument before inspecting the condition of the housing for damage that could allow fluid to enter the case interior.*
- *Do not allow fluids to enter the instrument. Fluid leakage into the instrument can cause damage.*
- *Do not invert the instrument when cleaning or rinsing, to prevent fluids from possibly leaking into the instrument.*
- *Do not immerse the instrument.*
- *Do not steam, autoclave, or EtO gas sterilize the instrument.*
- *Do not use pressurized air to dry the mechanisms after cleaning. Pressurized air force could move fluid past moisture seals and fluid leakage into the instrument can cause damage.*
- *Do not use organic solvents, ammonia, ammonium-based agents, isopropyl alcohol, and/or abrasive cleansers for cleaning.*
- *Do not use sharp or metallic tools to remove residue.*

Cleaning Solutions

Solution		Acceptable Area of Use
• mild, non-abrasive, non-staining solution (e.g., commercially available, alcohol free, dish washing liquid), well diluted with warm water	➧	instrument exterior pumping mechanism area
• mild, non-abrasive, non-staining, standard hospital disinfectant (e.g., water with up to 10% bleach)	➧	instrument exterior

NOTE: After cleaning with a bleach solution thoroughly rinse the area with water.

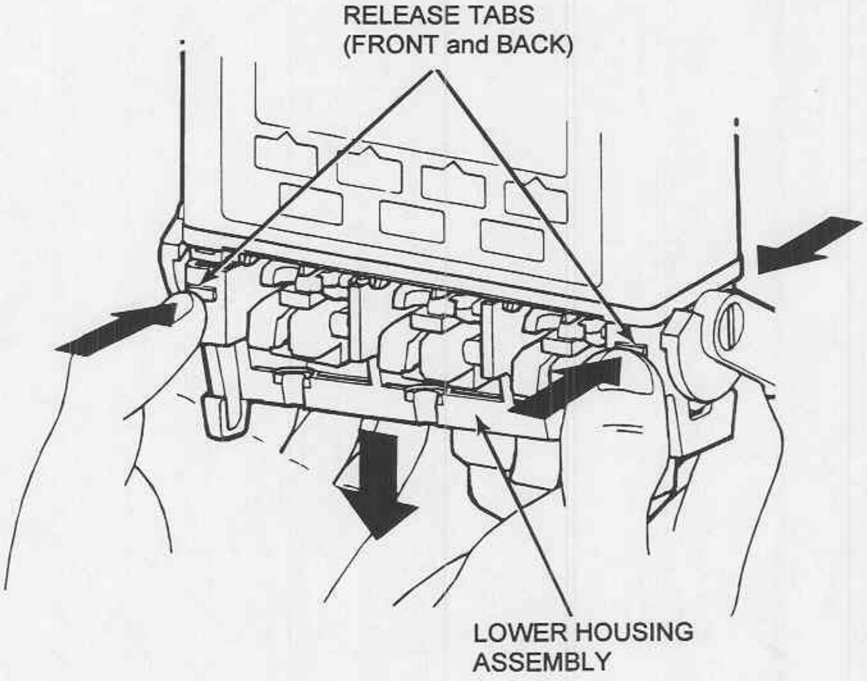
A. Instrument Exterior

1. Routinely clean the exterior surfaces of the instrument, using a cloth dampened with the appropriate cleaning solution, as specified in the "Cleaning Solutions" section.
2. Rinse with a cloth dampened with water.
3. Wipe dry with a clean dry cloth or allow to air dry.

B. Lower Housing Removal to Access Pumping Mechanisms (*See figure 1*)

To access the pumping mechanisms remove the lower housing by simultaneously depressing the four black release tabs and pulling straight down.

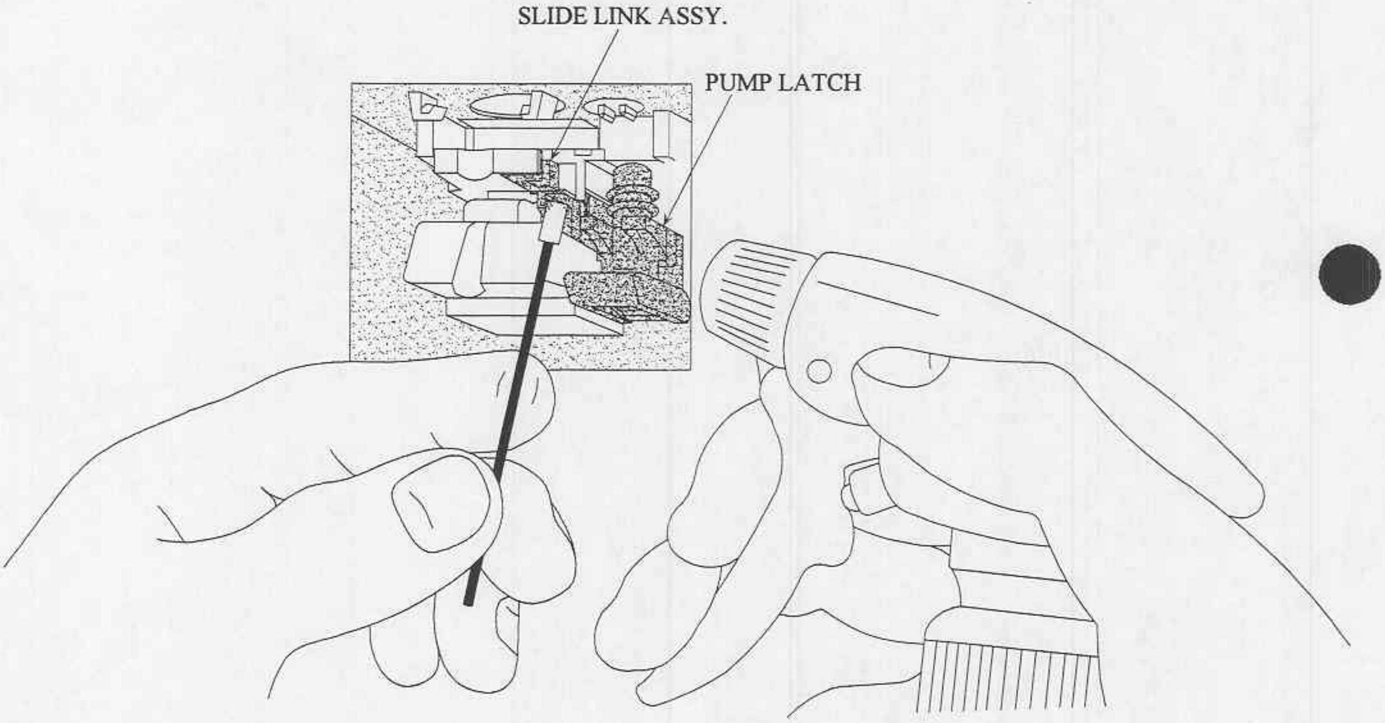
Figure 1 **-** *Lower Housing Removal*



C. Slide Link and Pumping Mechanism (*See figure 2*)

1. Place the instrument in the upright position.
2. Clean the slide link and pump latch mechanism using a small soft-bristled brush (or lint free swab) dampened with the appropriate cleaning solution, as specified in the "Cleaning Solutions" section. If dried residue is difficult to remove, or the slide link or pump latch sticks, spray the cleaning solution on the residue and allow it to soak until it can be more easily removed.
3. After removing residue, rinse with a lint free swab dampened with water. Water may be sprayed on the cleaned surfaces to rinse areas that are difficult to reach with a swab.
4. Dry with a lint free swab or cloth, or allow to air dry.

Figure 2 - *Slide Link and Pump Latch*



D. Air-in-Line Sensor (*See figure 3*)

NOTE: Air-in-line alarms may occur when dried residue builds up in the air-in-line sensor tubing recess.

1. Inspect the air-in-line sensor module to ensure that there is no separation or breakage of the glued seams.

   NOTE: Defective air-in-line sensor modules must be replaced before using the instrument.

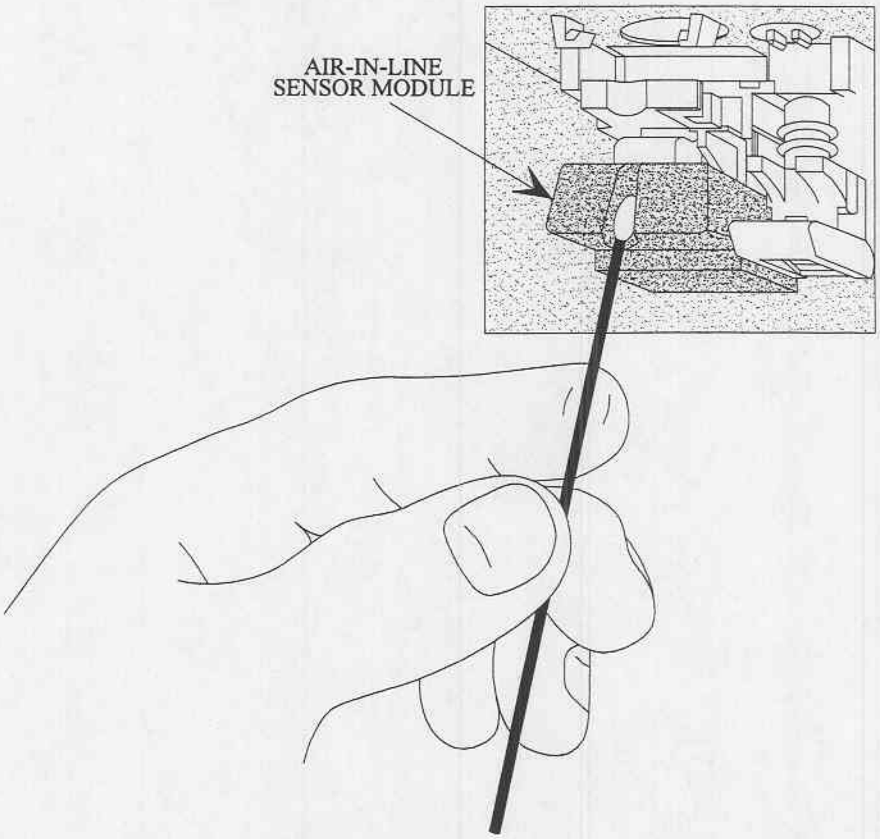
2. Place the instrument in the upright position.
3. Clean the tubing recess (using a downward motion) with a lint free swab dampened with the appropriate cleaning solution, as specified in the "Cleaning Solutions" section.

CAUTION

Use of abrasives or abrasive cleaners on the air-in-line sensor recess may cause false Air-in-Line or Check Air Sensor alarms.

4. Rinse with a lint free swab dampened with water.
5. Dry with a lint free swab or allow to air dry.

Figure 3 - *Air-in-Line Sensor*



E. Optomodule (*See figure 4*)

WARNING

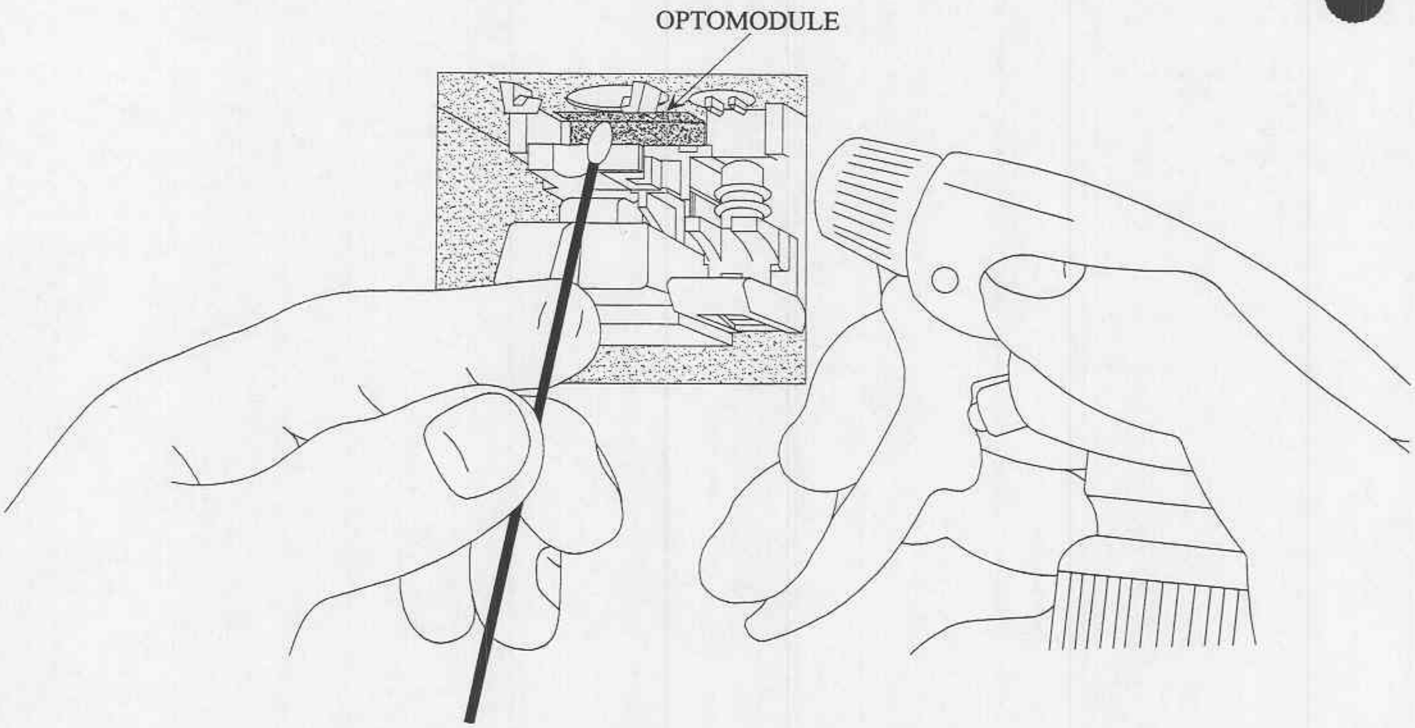
When cleaning the optomodule use EXTREME CARE to avoid damage to valve actuators. Damage or breakage of the actuator tips could cause an uncontrolled flow condition.

CAUTION

Do not use isopropyl alcohol or chlorine water on the optomodule.

1. Place the instrument in the upright position.
2. Gently clean the optomodule using a lint free swab dampened with the appropriate cleaning solution, as specified in the "Cleaning Solutions" section. The cleaning solution may be sprayed on difficult to remove residue to help wet and soften the residue for easier removal.
3. After removing residue, gently rinse with a lint free swab dampened with water. Water may be sprayed on the cleaned surfaces to rinse areas that are difficult to reach with a swab.
4. Gently dry with a lint free swab or allow to air dry.

Figure 4 - *Optomodule*



F. Valve Actuator (*See figure 5*)

WARNING

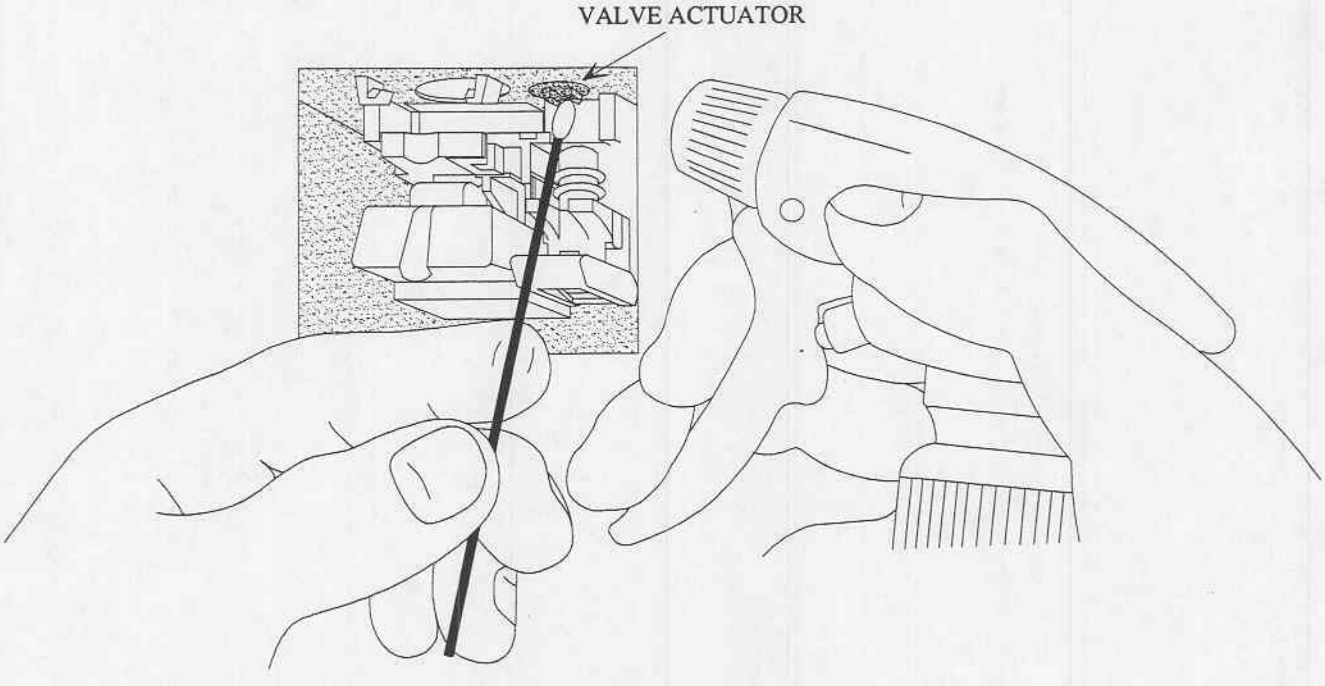
Care must be taken when cleaning the vicinity of the valve actuators to avoid damage and breakage of the actuator tips. Damage or breakage of the actuator tips could cause an uncontrolled flow condition.

CAUTION

Do not use isopropyl alcohol to clean the valve actuators.

1. Place the instrument in the upright position.
2. Gently clean the valve actuator and actuator seal area using a lint free swab dampened with the appropriate cleaning solution, as specified in the "Cleaning Solutions" section. The cleaning solution may be sprayed on difficult to remove residue to help wet and soften the residue for easier removal.
3. After removing residue, gently rinse with a lint free swab dampened with water. Water may be sprayed on the cleaned surfaces to rinse areas that are difficult to reach with a swab.
4. Gently dry with a lint free swab or allow to air dry.
5. After cleaning, inspect the exposed tips of the valve actuators. A broken tip may be supported by the actuator seal and not appear defective. Lightly attempt to push the tips of the valve actuators from side to side with a dry lint free swab. If a tip is not rigid, then it is broken and must be replaced before using the instrument.

Figure 5 - *Valve Actuator*



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Service Bulletin 396A

P/N 141356A

Service Bulletins are supplements to IVAC technical service manuals.

Model Affected: IVAC MedSystem III™ Multi-Channel Infusion Pump - 2860/2863
Date: August 1996
Subject: Power Supply Board Schematic

This supersedes Service Bulletin 396, to update the schematic reference for C102 (from 0.47μF).

Purpose

The purpose of this bulletin is to provide Biomedical Technicians with current power supply board schematic references.

Explanation

Various component changes have been made on the power supply board assembly, to accommodate the use of more readily available components, and eliminate the need for jumpers. A new power supply board schematic has been released to reflect the latest board assembly layout.

References

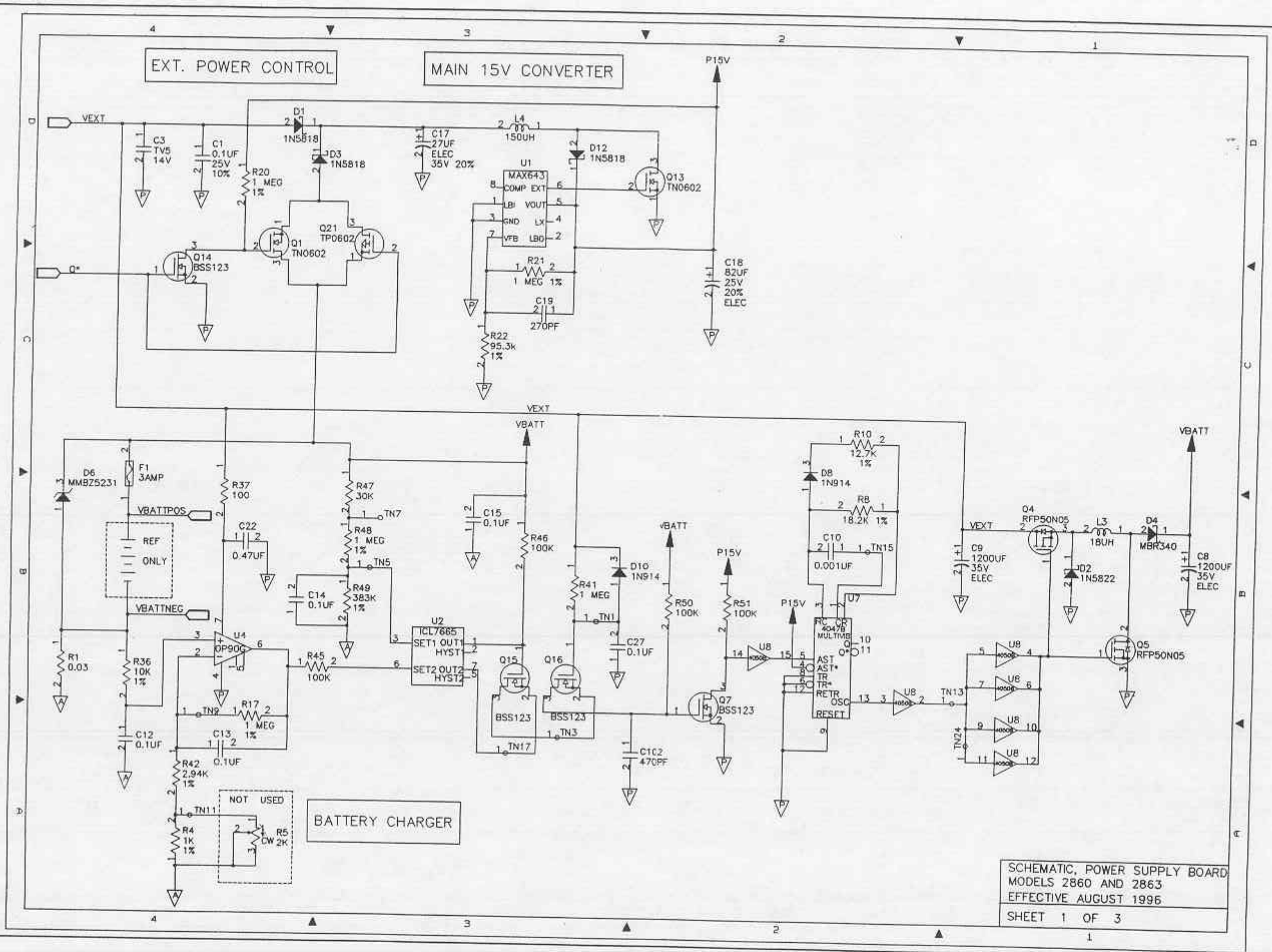
Model 2860/2863 Technical Service Manual

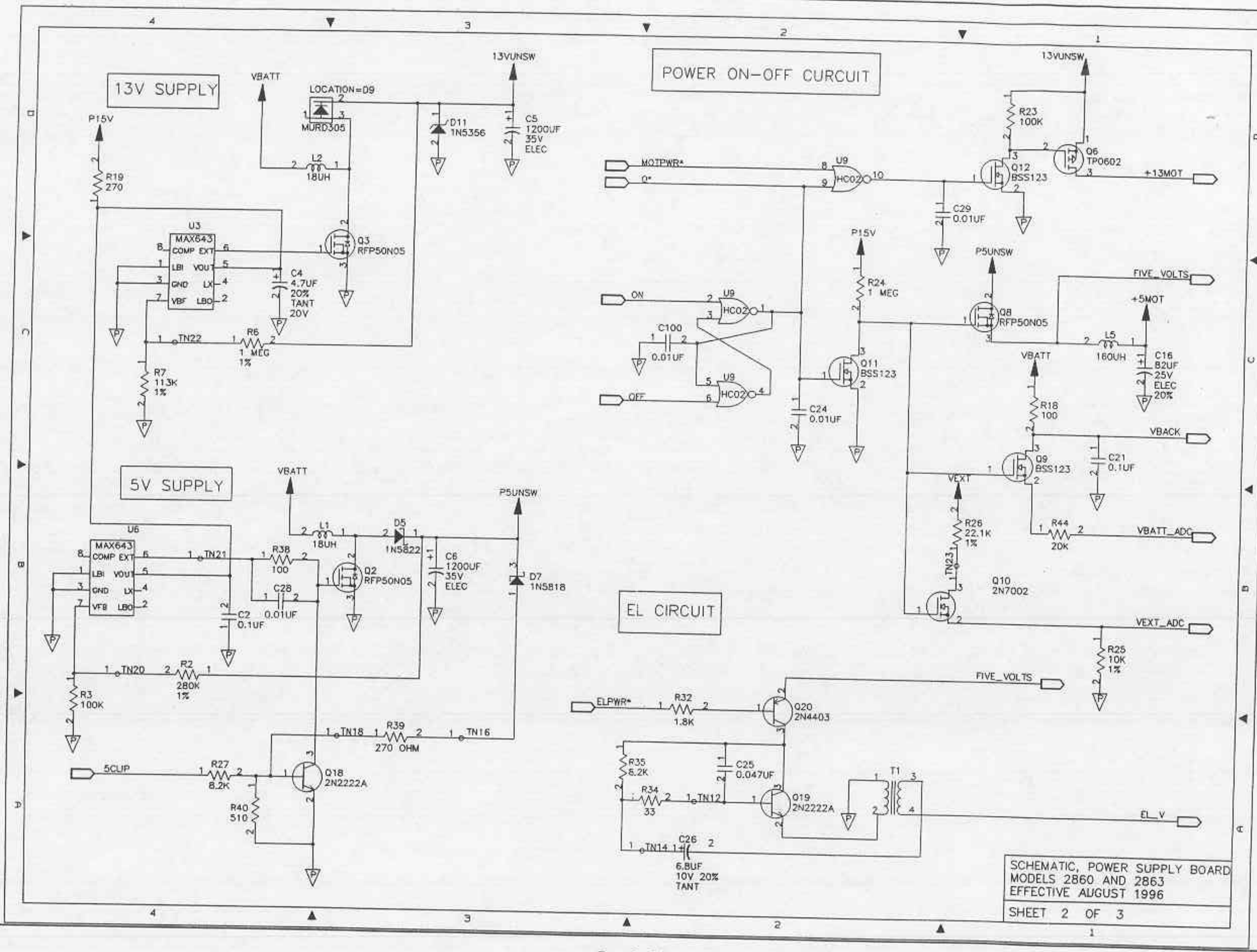
Parts and Tools Required*

Reference the service manual assembly, if servicing becomes necessary.

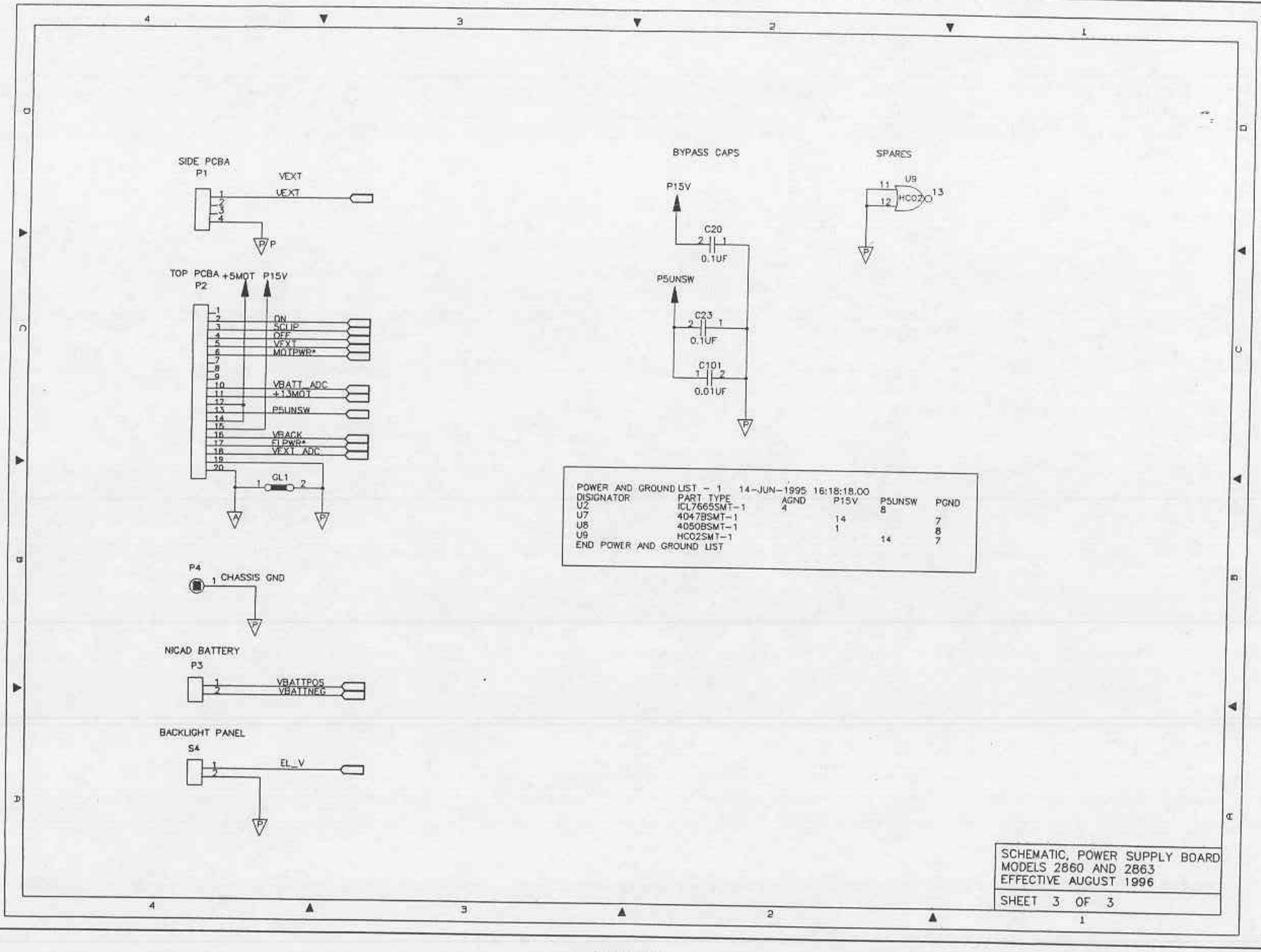
Recommended Action

Add the following power supply board schematic to the service manual references.


EXT. POWER CONTROL
MAIN 15V CONVERTER
BATTERY CHARGER
P15V
VEXT
VBATT
VBATTPOS
VBATTNEG
Q*
D1 1N5818
D3 1N5818
D12 1N5818
C3 TV5 14V
C1 0.1UF 25V 10%
R20 1 MEG 1%
Q14 BSS123
Q1 TN0602
Q21 TP0602
C17 27UF ELEC 35V 20%
L4 150UH
U1 MAX643
COMP EXT VOUT LX LBI GND VFB LBO
Q13 TN0602
R21 1 MEG 1%
C19 270PF
R22 95.3k 1%
C18 82UF 25V 20% ELEC
D6 MMBZ5231
F1 3AMP
REF ONLY
R1 0.03
R36 10K 1%
R37 100
C22 0.47UF
C12 0.1UF
U4 OP90G
R17 1 MEG 1%
C13 0.1UF
TN9
R42 2.94K 1%
TN11
R4 1K 1%
NOT USED
R5 2K CW
R47 30K
TN7
R48 1 MEG 1%
TN5
R49 383K 1%
C14 0.1UF
R45 100K
U2 ICL7665
SET1 OUT1 HYST1
SET2 OUT2 HYST2
C15 0.1UF
R46 100K
Q15 BSS123
Q16 BSS123
TN17
TN3
R41 1 MEG
TN1
D10 1N914
C27 0.1UF
C102 470PF
R50 100K
R51 100K
Q7 BSS123
U8
U7 4047B MULTIVIB
RC CR AST AST* TR TR* RETR OSC RESET Q Q*
R10 12.7K 1%
D8 1N914
R8 18.2K 1%
C10 0.001UF
TN15
TN13
TN24
C9 1200UF 35V ELEC
Q4 RFP50N05
L3 18UH
D2 1N5822
D4 MBR340
C8 1200UF 35V ELEC
Q5 RFP50N05
SCHEMATIC, POWER SUPPLY BOARD
MODELS 2860 AND 2863
EFFECTIVE AUGUST 1996
SHEET 1 OF 3


13V SUPPLY
P15V
R19
270
U3
MAX643
COMP EXT
LBI VOUT
GND LX
VBF LBO
VBATT
LOCATION=D9
MURD305
L2
18UH
Q3
RFP50N05
C4
4.7UF
20%
TANT
20V
TN22
R6
1 MEG
1%
R7
113K
1%
13VUNSW
D11
1N5356
C5
1200UF
35V
ELEC
POWER ON-OFF CURCUIT
MOTPWR*
O*
U9
HC02
R23
100K
Q12
BSS123
Q6
TP0602
+13MOT
C29
0.01UF
P15V
R24
1 MEG
P5UNSW
Q8
RFP50N05
FIVE_VOLTS
+5MOT
ON
OFF
C100
0.01UF
Q11
BSS123
C24
0.01UF
L5
160UH
C16
82UF
25V
ELEC
20%
VBATT
R18
100
VBACK
Q9
BSS123
C21
0.1UF
VEXT
R26
22.1K
1%
R44
20K
VBATT_ADC
TN23
Q10
2N7002
VEXT_ADC
R25
10K
1%
5V SUPPLY
U6
MAX643
COMP EXT
LBI VOUT
GND LX
VFB LBO
TN21
R38
100
C28
0.01UF
L1
18UH
Q2
RFP50N05
D5
1N5822
C6
1200UF
35V
ELEC
D7
1N5818
C2
0.1UF
TN20
R2
280K
1%
R3
100K
TN18
R39
270 OHM
TN16
5CLIP
R27
8.2K
R40
510
Q18
2N2222A
EL CIRCUIT
FIVE_VOLTS
ELPWR*
R32
1.8K
Q20
2N4403
R35
8.2K
C25
0.047UF
R34
33
TN12
Q19
2N2222A
T1
EL_V
TN14
C26
6.8UF
10V 20%
TANT
A
B
C
D
1
2
3
4

SCHEMATIC, POWER SUPPLY BOARD
MODELS 2860 AND 2863
EFFECTIVE AUGUST 1996
SHEET 2 OF 3


4
3
2
1
D
C
B
A
SIDE PCBA
P1
VEXT
VEXT
1
2
3
4
P
P
TOP PCBA
P2
+5MOT
P15V
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
ON
5CLIP
OFF
VEXT
MOTPWR*
VBATT_ADC
+13MOT
P5UNSW
VBACK
ELPWR*
VEXT_ADC
GL1
1
2
A
P
P4
1
CHASSIS GND
P
NICAD BATTERY
P3
1
2
VBATTPOS
VBATTNEG
BACKLIGHT PANEL
S4
1
2
EL_V
P
BYPASS CAPS
P15V
C20
2
1
0.1UF
P5UNSW
C23
2
1
0.1UF
C101
1
2
0.01UF
P
SPARES
U9
11
12
HC02
13
P

POWER AND GROUND LIST - 1 14-JUN-1995 16:18:18.00

DISIGNATOR	PART TYPE	AGND	P15V	P5UNSW	PGND
U2	ICL7665SMT-1	4		8	
U7	4047BSMT-1		14		7
U8	4050BSMT-1		1		8
U9	HC02SMT-1			14	7

END POWER AND GROUND LIST

SCHEMATIC, POWER SUPPLY BOARD
MODELS 2860 AND 2863
EFFECTIVE AUGUST 1996

SHEET 3 OF 3

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Service Bulletin 402

P/N 136980A

Service Bulletins are supplements to imed • IVAC technical service manuals.

Model Affected: IVAC MedSystem III™ Multi-Channel Infusion Pump, Model 2860/2863
Date: January 1997
Subject: New Side Board Assembly

Purpose

The purpose of this bulletin is to provide Biomedical Technicians the following:

- part replacement information related to the release of a two-connector side board assembly, and
- an explanation of the need to disconnect the instrument from AC power before connecting or disconnecting the computer communications cable.

This is *reference information only* and is not intended to suggest a need for component changes.

Explanation

- Side Board Assembly

  The side board assembly (described as "Audio/Connector PCBA" in the service manual) has been redesigned to incorporate ESD protection and eliminate three unused connectors. A two-connector version of the connector label has been released. When replacing a five-connector side board assembly with a two-connector side board assembly, the five-connector version of the connector label must be replaced with the two-connector version of the label.

- Computer Communications Cable Connection/Disconnection

  To prevent possible damage to the communications chip, on the main electronics assembly, the instrument needs to be disconnected from AC power before connecting or disconnecting the computer communications cable.

References

Model 2860/2863 Technical Service Manual (*identified with P/N 139981*)

Parts and Tools Required*

As specified in the appropriate sections of the service manual, when servicing is required.

Parts Ordering:	Refer to Appendices chapter of the Technical Service Manual
Parts Inquiries:	1-800-854-7128, 1-619-458-6005
Technical Inquiries:	1-800-854-7128, 1-619-458-6003, FAX 1-619-458-7507

Recommended Action

Include the following information as a service manual reference when replacing the side board assembly, connector label, or main housing assembly.

Side Board Assembly

NOTE: When ordering a side board assembly specify whether it is for a Model 2860 or 2863.

When replacing a five-connector side board assembly with a two-connector side board assembly, the replacement kit will contain all the necessary parts and instructions, as follows:

- Side Board Assembly
- Lock Washers (2)
- Connector Label (two-connector version)
- Installation Instructions (identifying connector label usage)

Model 2860: As of the publication date of this bulletin the five-connector version of the side board assembly kit may still be in use, as P/N 2860612. The two-connector version will contain the above parts.

Model 2863: Order using P/N 2863352 (new).

Main Housing Assembly and Connector Label

When replacing a main housing assembly or connector label, the replacement kit will include both the five-connector and two-connector versions of the connector label and installation instructions identifying label usage.

The main housing assembly has not changed; it will continue to have five side board connector holes. When a two-connector side board assembly is installed, the two-connector version of the connector label will cover and seal the three unused connector holes in the main housing.

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Service Bulletin 404A

P/N 141592A

Service Bulletins are supplements to IVAC technical service manuals.

Model Affected: IVAC MedSystem III™ Multi-Channel Infusion Pump, Model 286X
Date: October 1996
Subject: Level of Testing Guidelines

Purpose

The purpose of this bulletin is to provide Biomedical Technicians the following:

- A Level of Testing Guidelines table, to replace all existing references to testing required after repair (*reference Repair chapter of service manual*).
- An Audio Test (*new*), and updated procedures for the Electrical Safety and Run-In tests (*reference System Functional Tests chapter, and Procedures Following Repair section in Repair chapter of service manual*).
- Procedures to help ***troubleshoot***:
    a. NiCad battery problems (*reference NiCd Battery Problems Table in Troubleshooting chapter of service manual*).
    b. Instrument memory loss problems.

Explanation

- The tests currently specified in the service manual as being required after repair/reassembly may not reflect current testing requirements or recommendations. To help provide the most current minimum test requirements and recommended tests, a Level of Testing Guidelines table has been provided.
- The Electrical Safety and Run-in tests currently specified in the service manual have been replaced to provide the current test procedures (*Electrical Safety Test, and Run-In On AC Power*). A procedure for checking the audio volume has been provided (*Audio Test*).
- Procedures are being provided to verify:
    a. that the Nicad battery is being charged within specification (*NiCad Battery Charge Current Test*),
    b. that the current drawn from the NiCad battery, when the instrument is operating on battery power, is within specification (*Standby Current Test*),
    c. that the NiCad battery can provide sufficient instrument operating time after it has discharged and recharged (*Battery Functional Test*), and
    d. that the current drawn from the backup battery, when the instrument is off, is within specification (*Ram Standby Current Test*).

Parts Ordering:	Refer to Appendices chapter of the Technical Service Manual
Parts Inquiries:	1-800-854-7128, 1-619-458-6005 6003
Technical Inquiries:	1-800-854-7128, 1-619-458-6003, FAX 1-619-458-7507

References

Model 2860/2863 Technical Service Manual (*identified with P/N 139981*)
Applicable Field Maintenance Software Operating Instructions (FMS DFU)
Applicable Instrument's Directions For Use (DFU)

Parts, Tools, and Equipment Required*

- Equipment referenced, as necessary, under each test procedure in this bulletin.
- Appropriate field Maintenance Software (FMS) Kit

* These are in addition to parts, tools, and equipment referenced in the service manual.

Recommended Action

Add this Service Bulletin to your Model 2860/2863 Technical Service Manual, as a supplement to the System Functional Tests, Troubleshooting, and Repair Chapters.

CAUTION

Static charges will damage instrument circuitry. Always wear a grounded wrist strap while disassembling and assembling the instrument. Periodically check the ground point and wrist strap continuity.

The instrument consists of electrical and mechanical components that operate as a system. When repairing or replacing an instrument's components, whether electrical or mechanical, refer to the disassembly and reassembly procedures (*reference Repair chapter of service manual*).

NOTE: Restoration of Configured Parameters, and Battery History Log Memory contents, serial number, and special message can be corrupted during repair. Field Maintenance Software (FMS) may have been used to customize configuration settings, or program drug lists for Dose Rate Calculator. All settings should always be verified for correctness after repair. For reprogramming instructions refer to the appropriate FMS DFU.

1. Level of Testing Guidelines

Any instrument repair or disassembly must be followed by testing, determined by the level of the repair/disassembly. Use the following Level of Testing Guidelines, Table 1, in place of the test requirements specified in the Repair chapter of the service manual, in the Procedure Following Repair section and following each reassembly procedure.

Repair or replacement of the following parts does not require testing, unless it is part of a higher level repair, as listed in Table 1.

- Chassis Mounts
- Dust Cap
- Lower Housing Assembly
- Universal Pole Clamp

Table 1 Level of Testing Guidelines

Tests to Perform ➡

● = Required
✗ = Optional

Repair/Replacement of ⬇	Battery Charge Current Test	Standby Current Test	RAM Standby Current Test	Pump Latch Height Adjustment (7.3.2)	Valve Actuator Height Verification (7.3.6)	Full Calibration using FMS (5.0)	Electrical Safety Test (3.1)	Power Tests (3.2)	Cassette and Sensor Test (3.3)	PSOD Test (3.4)	FSOD Test (3.5)	AIL Test (3.6)	Volume Accuracy Test (3.7)	Watchdog Audio Test (3.9)	Audio Test	Battery Functional Test	Run-In AC Power
No Fault Found							●	●									
Adapter							●	●									
Air-in-Line Sensor						●	●	●	●								
Audio PCBA (Side Brd. Assy.)							●	●							●		
Backup Battery			●			●	●	●									
Battery Pack	●	●					●	●								✗	
Display Module							●	●									
Drive Module Assembly				●	●	●	●	●	●	●	●		●				
EPROM Module							●	●									
Main Housing Assembly							●	●						●			
MEA (Logic Board Assy.)		●	●			●	●	●	●	●	●	●	●	●	●	✗	✗
Optomodule						●	●	●	●								
Power Supply Board Assembly	●	●				●	●	●								✗	✗
Power Supply Fuse							●	●									
Pressure Transducer						●	●	●	●	●							
Pump Latch Assembly and Shaft Seal (case was removed)				●		●	●	●	●	●	●		●				
Pump Latch Assy. and Shaft Seal (case was not removed)				●				●	●				●				
Pump Latch Movable Jaw								●	●								
Pump Shaft				●	●	●	●	●	●	●	●		●				
Slide Link						●		●	●				●				
Valve Actuator Assembly				●	●	●	●	●	●	●	●		●				

2. Electrical Safety Test

Equipment Required:

- Electrical Safety Tester, Dale Technology Corporation, Model LT544D, or equivalent

This test checks the ground continuity and leakage current of the AC adapter/instrument, and can only be performed with the AC adapter connected to the instrument.

NOTE: The pole clamp is isolated from the internal electronics and, therefore, is not grounded. It should not be used while performing the electrical safety test.

a. Refer to the operation manual, for the electrical safety tester, for the proper setup and measurement technique.

b. Connect the AC adapter to the instrument.

c. Plug the AC adapter into the electrical safety tester.

d. Measure the ground continuity and leakage current. Any point of an instrument with an aluminum chassis can be used for testing. A black coated chassis can only be tested at the uncoated test point, located toward the back of the chassis under the lower housing (*reference Figure 3-1 in System Functional Tests chapter of service manual*). Verify the following:

  - Ground continuity not to exceed 0.1 ohm.
  - Leakage current not to exceed 100μA.

3. NiCad Battery Charge Current Test

Equipment Required:

- Digital Multimeter (DMM)
- Test harness for measuring battery charge current (*reference Figure 2*)
- Anti-Sabotage Inspection Lacquer, or equivalent
- Known good battery pack

a. Ensure that:

  - the instrument is off and not connected to AC power,
  - the battery pack is not connected to the instrument, and
  - the case assembly is mounted to the instrument.

b. Determine if the power supply board assembly has potentiometer R5. The potentiometer (R5) is used for adjusting the battery charge current and, if present, will be found only on one of the earlier versions of the power supply board assembly. Earlier versions of the board assembly are easily identified from the most current version by having components on both sides. If the earlier version of the power supply board assembly is present, check for the presence of R5, as follows:

  - Check the power supply board prior to reinstalling the case assembly (*reference Figure 1A*), if the case was removed for repair of the instrument.

    NOTE: Component layout may vary from one version of the board assembly to another, but if present, R5 will always be located in the same area.

    OR

  - View the instrument from above and check for R5 at the edge of the power supply board (*reference Figure 1B*).

  NOTE: The battery charge current specification is dependent upon the version of the power supply board assembly in use.

c. Set up the Digital Multimeter (DMM) to measure mA DC.

d. Connect a known good battery pack, in series with the DMM, to the battery pack cable assembly on the instrument (*reference Figure 2*).

e. Connect the instrument to AC power. Verify that the AC indicator (green plug-shaped light on the side connector panel) is lit and does not blink if the AC connection is wiggled. Verify that the instrument powers on and off.

3. NiCad Battery Charge Current Test (Cont'd.)

f. With the instrument off verify that the charge current to the battery pack meets one of the following specifications, as appropriate for the power supply board assembly in use.

- power supply board assembly with potentiometer (R5):
  170 mA - 180 mA
- power supply board assembly with components on both sides and without R5:
  160 mA - 235 mA
- power supply board assembly with components only on one side:
  100 mA - 410 mA

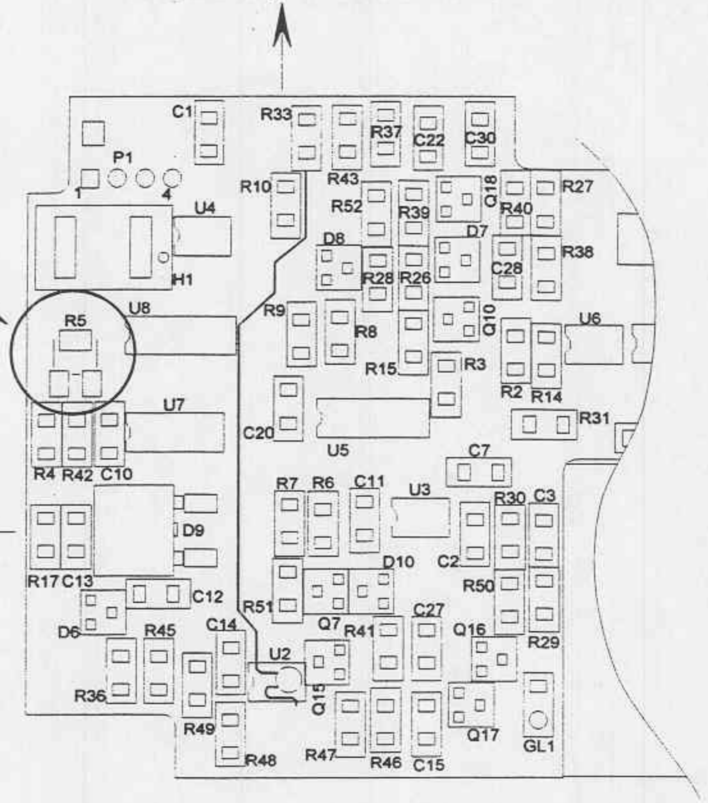
NOTE: If there is no current measurement, ensure that the fuse on the power supply board is not blown.

g. If the power supply board has R5, and the charge current is slightly out of specification, R5 may be adjusted to bring the charge current within specification. After adjustment apply Inspection Lacquer (or equivalent) to lock the adjustment in place.

CAUTION

Use extreme care if adjusting R5; it is easily damaged.

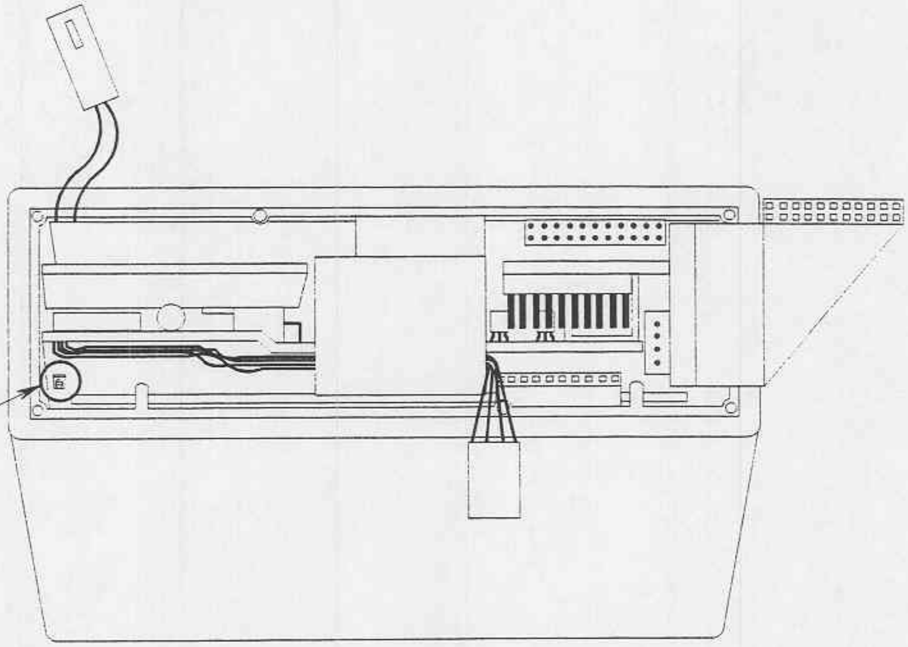
Figure 1A - R5 Location - Partial view of power supply board assembly (sample version).


Toward top of instrument.

If present, R5 will be located in this area.

Toward left side of instrument.
C1
R33
R37
C22
C30
P1
1
4
R10
R43
R52
R39
Q18
R40
R27
U4
D8
D7
R28
R26
C28
R38
H1
U8
R5
R9
R8
Q10
U6
R15
R3
R2
R14
U7
R31
C20
U5
C7
R4
R42
C10
R7
R6
C11
U3
R30
C3
D9
D10
C2
R17
C13
R50
C12
R51
C27
D6
R45
C14
Q7
R41
Q16
R29
U2
R36
Q15
R49
Q17
GL1
R48
R47
R46
C15

Figure 1B - R5 Location - View from top of instrument.


If present, R5 can be seen on the power supply brd. assy. in this area.

4. Standby Current Test

Equipment Required:

- Digital Multimeter (DMM)
- Test harness for measuring battery charge current (*reference Figure 2*)
- Known good battery pack

a. Ensure that:

  - the instrument is off and not connected to AC power,
  - the battery pack is not connected to the instrument, and
  - the case assembly is mounted to the instrument.

b. Set up the Digital Multimeter (DMM) to measure mA DC.

c. Connect a known good battery pack, in series with the DMM, to the battery pack cable assembly on the instrument (*reference Figure 2*).

d. Connect the instrument to AC power and verify that the instrument powers on and off.

e. Disconnect the instrument from AC power.

f. Turn the instrument on.

g. With the instrument on but not running, verify that the current drawn by the instrument is less than 400 mA.

h. Turn the instrument off.

i. Set the DMM to µA DC range.

j. Verify that the current drawn by the instrument is less than 100 µA.

NOTE: If the current is not within the specifications, there may be a problem with the power supply board or the MEA board (logic board assembly).

5. RAM Standby Current Test

Equipment Required:

- Digital Multimeter (DMM)
- Test harness for measuring RAM standby current (*reference Figure 3*)

NOTE: Corruption of existing memory contents may occur when this test is performed. If memory is corrupted, complete recalibration will be necessary. All custom instrument parameters originally set by using FMS will also require reprogramming.

a. Ensure that the instrument:

   - is off and not connected to AC power, and
   - powers on and off while on battery power.

b. Remove the battery pack.

   - Model 2860: Leave the battery pack harness connected to the instrument.
   - Model 2863:
     1. Disconnect the battery pack harness.
     2. Remove the main housing.
     3. Reconnect the battery pack harness.

c. Set the Digital Multimeter (DMM) to µA DC range.

d. Connect the instrument's backup battery in series with the DMM (*reference Figure 3*).

   NOTE: On the Model 2860, the backup battery connects to the top interconnect board on the MEA board (*reference Figure 7-16 in Repair chapter of service manual*). On the Model 2863, the backup battery connects to the MEA board (logic board) (*reference Figure 7-121 in Repair chapter of service manual*).

e. Verify that the backup current drawn by the instrument is:

   - Model 2860: less than 25 µA

   OR

   - Model 2863: less than 100 µA

   NOTE: If the current is not within the specification, there may be a problem with the MEA board (logic board assembly).

Figure 2 - Setup for NiCad Battery Charge Current Test and Standby Current Test

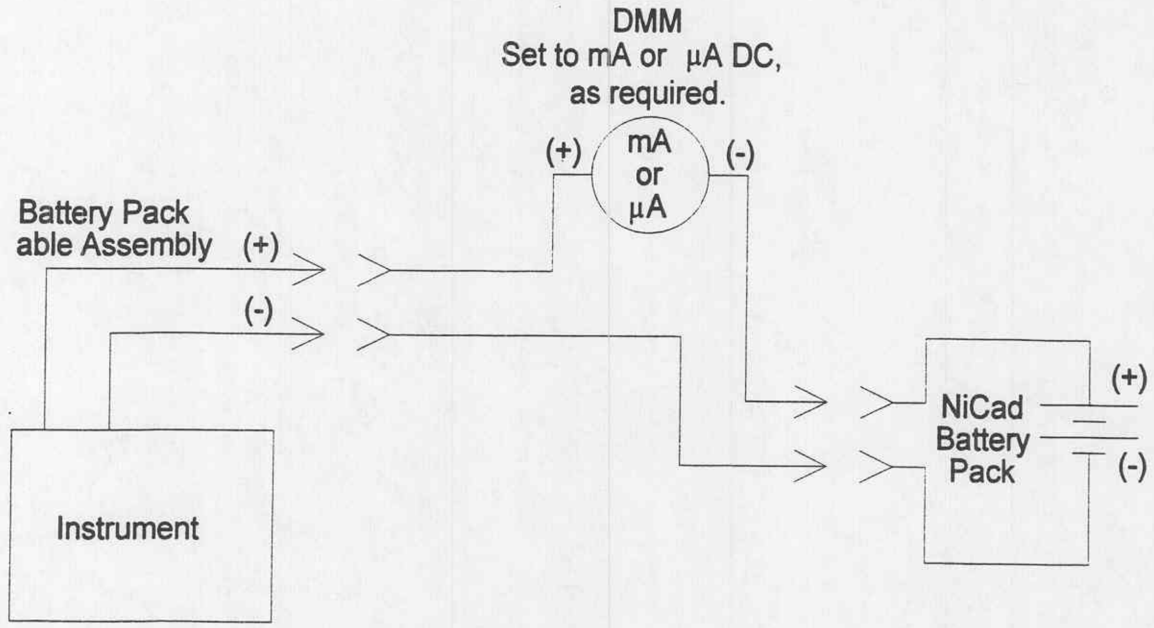
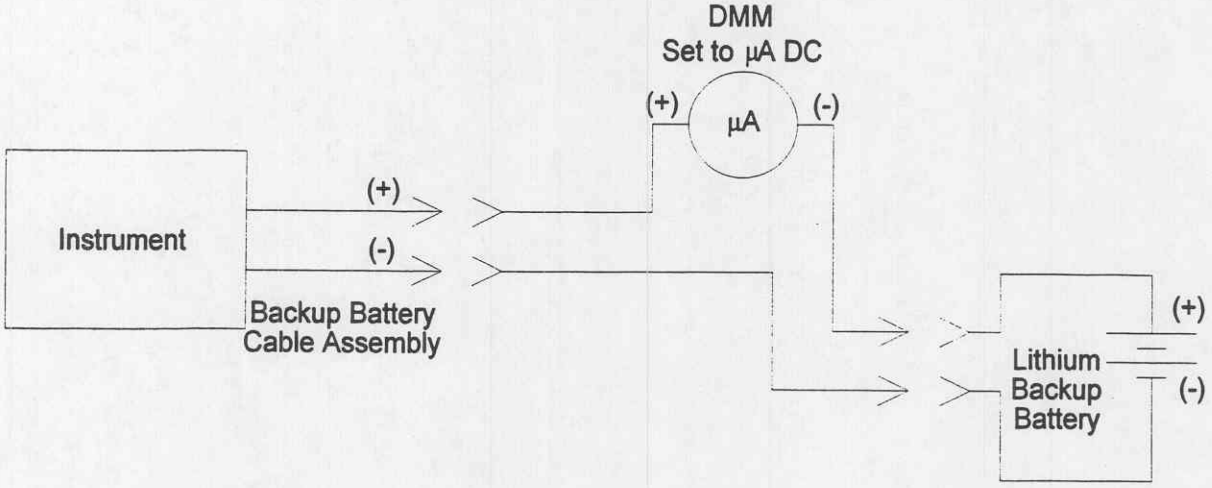

DMM
Set to mA or µA DC, as required.
(+)
mA or µA
(-)
Battery Pack able Assembly
(+)
(-)
Instrument
NiCad Battery Pack
(+)
(-)

Figure 3 - Setup for RAM Standby Current Test


DMM
Set to µA DC
(+)
µA
(-)
Instrument
(+)
(-)
Backup Battery Cable Assembly
Lithium Backup Battery
(+)
(-)

6. Battery Functional Test

a. Disconnect the instrument from AC.

b. Operate the instrument with all channels set at 999 ml/h, to test the 13V circuitry.

c. Continue operating past the Battery Depleted alarm, until the instrument shuts off.

d. Connect the instrument to AC.

e. Charge the instrument for 14 hours, while running all three channels at 002 ml/h, to test the 5V circuitry and battery charging circuit.

f. Perform the battery operating time functional test, while operating all three channels of the instrument at 125 ml/h (*reference Battery Operating Time section in System Functional Tests chapter of service manual*). The 5½ hours of operating time specified in this test is for new batteries. For used batteries, perform the same test with an operating time of 4 hours.

g. Repeat steps d through f if the battery does not meet the operating time specification.

h. With the instrument power off, recharge the instrument for 14 hours.

7. Run-In On AC Power

This test will exercise the instrument in three modes, secondary, primary, and KVO, for a minimum of 2 hours on all three channels. The instrument should be operated on AC power in the General Purpose mode. Fluid-filled cassettes need to be installed during the run-in period. Set up a circulating system, using a bag of saline.

a. Set Primary Mode

For all channels, set the primary rate to 999 ml/h and Volume Remaining to 1000 ml. Clear the Volume Infused on all channels to 0 ml.

b. Set Secondary Mode

For all channels, set the secondary rate to 125 ml/h and Volume Remaining to 125 ml. Clear the Volume Infused on all channels to 0 ml.

c. Begin running the instrument in the secondary mode on all channels. Set the instrument to display the current infusion information for all channels.

When the secondary mode is complete the instrument will automatically go into the primary mode. At the end of the primary mode of operation the instrument will go into the KVO mode at 3 ml/h. The instrument can run in the KVO mode until it is convenient to complete the test.

The instrument should not go into alarm during the run-in.

8. Audio Test

This procedure checks the audio volume.

a. Disconnect the AC adapter from the instrument.

b. Remove any cassettes from the instrument.

c. Turn the instrument on and verify proper power-up, as described in the instrument's Directions for Use (DFU).

d. Refer to the instrument's DFU and access **Audio Volume:** in the Config (Configuration) option.

e. There are four volume settings: low, medium, high, and highest. Each volume setting has a distinct loudness. Set the volume to **Highest**.

f. Change the audio volume one setting. Listen for a musical tone progression, and at the highest note verify:

   - the jawhead in each channel does not move, and
   - that a watchdog does not occur.

g. Repeat step f. for the other three volume settings.

h. Ensure **Audio Volume:** is set to **Highest**.

i. Remove the lower housing.

j. Close the jawhead at each channel.

k. Verify a four-beep audio alarm with the red LEDs blinking.

   NOTE: The display returns to STANDARD DISPLAY and identifies that the channels are alarming.

l. Open the jawhead at each channel to cancel the alarm.

m. Turn the instrument off.

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Service Bulletin 405B

P/N 144995A

Service Bulletins are supplements to ALARIS Medical's Technical Service/Maintenance Manuals.

Model Affected: MedSystem III® Multi-Channel Infusion Pump – 2860, 2863, 2865, 2866
Date: July 1999
Subject: Power Supply Board Assembly - Surface Mount

☞ *This supersedes Service Bulletin 405A, to reflect changes to the VMAIN and +5V supply lines, and include reference to Models 2865 and 2866.*

Purpose

The purpose of this bulletin is to provide Biomedical Technicians with:

- instructions on how to identify whether or not the latest version of the power supply board assembly is installed,
- interchangeability impact information when replacing the power supply board assembly, and
- the schematic for the latest version of the power supply board assembly.

Explanation

The power supply board assembly has been redesigned to incorporate current technology (surface mount) and provide more readily available parts. It is easily identified by having all the components on one side of the board (all previous versions of the board assembly have components on both sides of the board). The battery cable assembly has also been incorporated as part of the new power supply board assembly.

Early versions of the surface mount power supply board assembly were manufactured with a 120µF tantalum chip capacitor that has proven to be unreliable. Failure of this capacitor may cause the instrument to stop without alarming. Instruments having a serial number above 3351884 were manufactured with a power supply board assembly upgraded to use a 220µF electrolytic capacitor in place of the 120µF tantalum chip capacitor.

To ensure the appropriate clearance between the 220µF capacitors on the power supply board assembly and a Model 2860 main electronics assembly (MEA), the hardware used to mount the power supply board assembly has been changed.

References

Model 2860/2863 Technical Service Manual (*identified as P/N 139981, ordered as P/N 2863012*)
Service Bulletin 404A (*or more current*), Level of Testing Guidelines
Service Bulletin 439 (*or more current*), ESD Handling Requirements and Cautions

Parts and Tools Required*

When installing a newly designed power supply board assembly onto a Model 2860 main electronics assembly (MEA), the following may be needed:

- two each - Washer, Nylon, 0.093" Thick; P/N 305632
- two each - Screw, Button Head, 2-56 x 1/4; P/N 305119

* These are in addition to parts, tools, and equipment referenced in the service manual. Reference the service manual assembly if servicing becomes necessary.

Recommended Action

CAUTION

Turn the instrument off and disconnect it from AC power before disassembly. Static charges will damage instrument circuitry. Observe proper grounding techniques (use grounding strap) to prevent possible harm to static-sensitive components. Reference current version of Service Bulletin 439.

A. To determine if a power supply board assembly, having surface mount components, has 120μF tantalum chip capacitors installed, perform the following steps:

NOTE: Through-hole power supply board assemblies do not use the tantalum capacitors.

1. Remove the battery pack, to allow a view of the inside of the instrument. (*Reference Repair chapter of service manual.*)
2. Position the instrument with the LCD display facing towards you and look down on the left edge of the power supply board assembly.
3. The latest version of the power supply board assembly, having surface mount components, will have seven electrolytic capacitors. Four of the electrolytic capacitors will be clearly visible near the top edge of the board assembly.

   NOTE: Electrolytic capacitors are cylindrical and approximately 3/8 in (10 mm) high, whereas, tantalum chip capacitors are rectangular and approximately 1/8 in (3 mm) high. (*See figure 1*)

   a. If the board assembly does not have surface mount components (through-hole board assembly), or the four electrolytic capacitors are present, proceed to step 4; otherwise, continue with the next step.

   b. If the board assembly has surface mount components and the four electrolytic capacitors are not present, contact ALARIS Medical Systems for a replacement board assembly. Installation instructions will be provided with the replacement power supply board assembly.
4. If the existing power supply board assembly is determined to be acceptable, reinstall the battery pack and test the instrument for "No Fault Found". (*Reference Repair and Systems Functional Tests chapters of service manual, and current version of Service Bulletin 404.*)

B. When replacing the power supply board assembly, reference the following steps:

1. When installing a newly designed power supply board assembly (components on one side) as a replacement for an earlier version of the board assembly (components on both sides), the battery cable assembly used with the board assembly being replaced is not needed and is to be removed from use. (*Reference Repair chapter of service manual.*)

2. When installing a newly designed power supply board assembly onto a Model 2860 main electronics assembly (MEA), change the board mounting hardware, as follows: (*See figure 2)*

   NOTE: This will eliminate the potential for interference between the power supply board assembly and the MEA. There is no interference issue when installing the power supply board assembly onto an ASIC logic board assembly.

   a. Install a 0.093" nylon washer, P/N 305632, between the power supply board assembly and each standoff on the MEA.

   b. Use the same insulating washer used in the original assembly (located between the screw and the power supply board assembly).

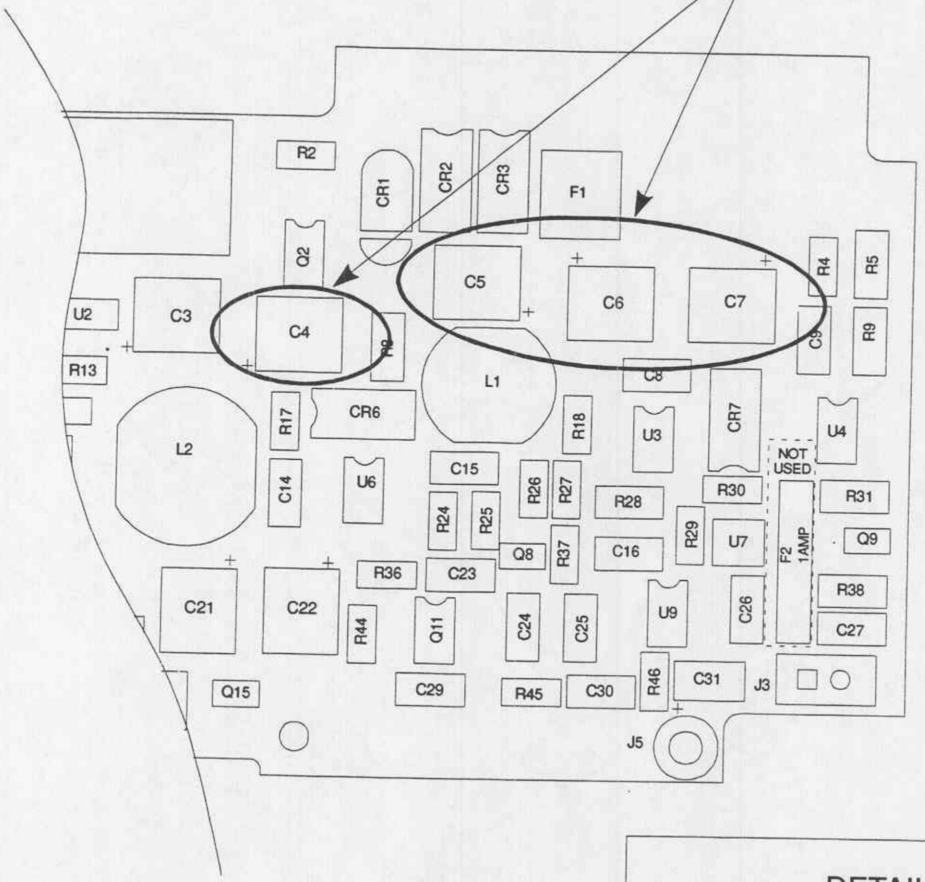
   c. Replace the 2-56 x 3/16 button head screws used in the original assembly with 2-56 x 1/4 button head screws, P/N 305119.

   NOTE: If the side cable, J1 on the power supply board assembly, has a ferrite bead, special care will be needed when installing the board assembly. As the board assembly is being installed, route the side cable (J1) between the power supply board assembly and the side board assembly, being careful to avoid an interference fit with the ferrite bead on the cable.

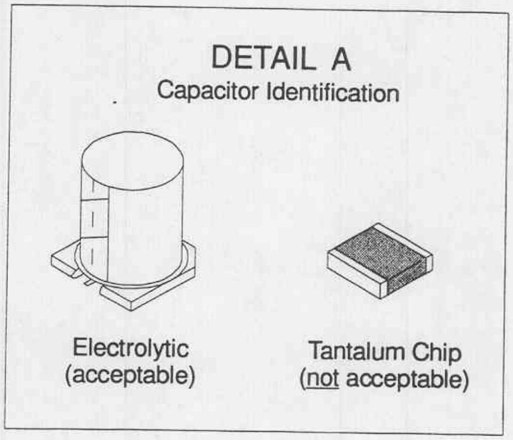
C. Add the new power supply board schematic to the service manual references.

Figure 1 — Capacitor Locations and Identification

NOTE: The following is a partial view of the component layout for the power supply board assembly. This view is for reference only, to help locate the four capacitors that will be clearly visible when the board is installed (steps A2 and A3), and to help identify the difference between a tantalum chip capacitor and an electrolytic capacitor.

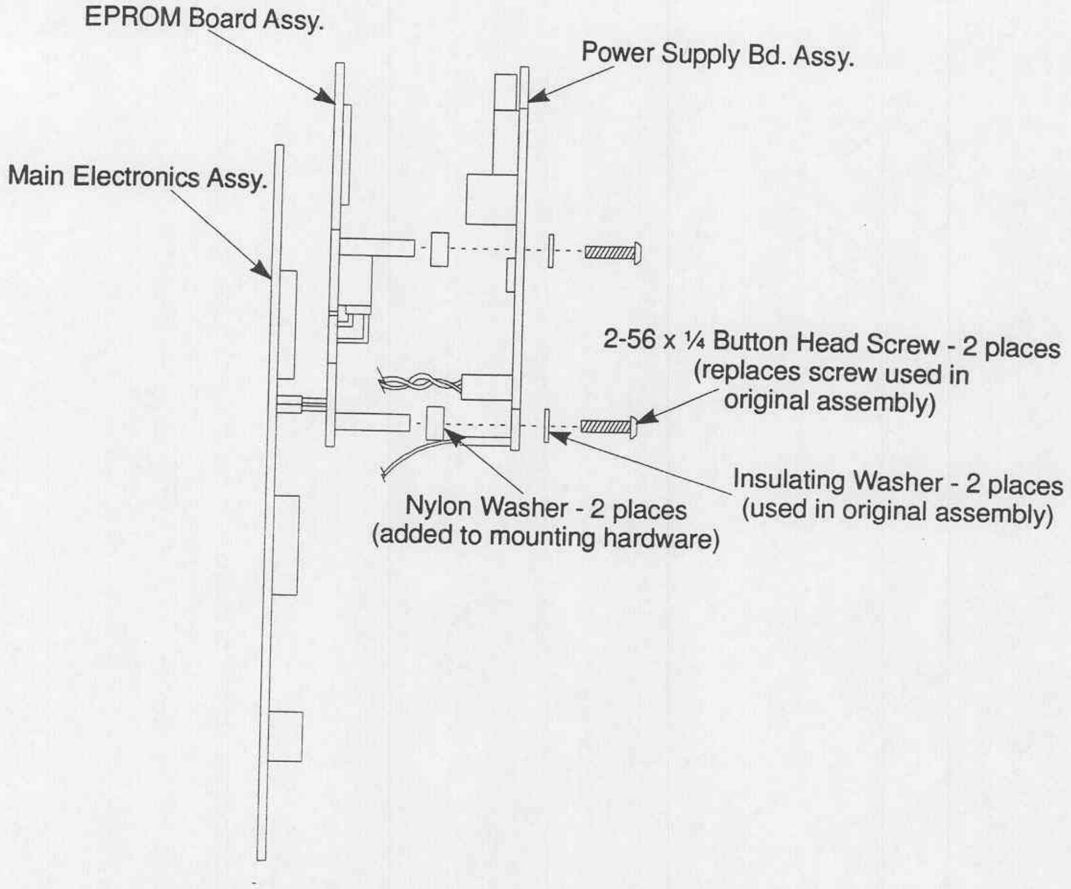

Electrolytic capacitors installed in these locations will be clearly visible when board is installed. (See Detail A)

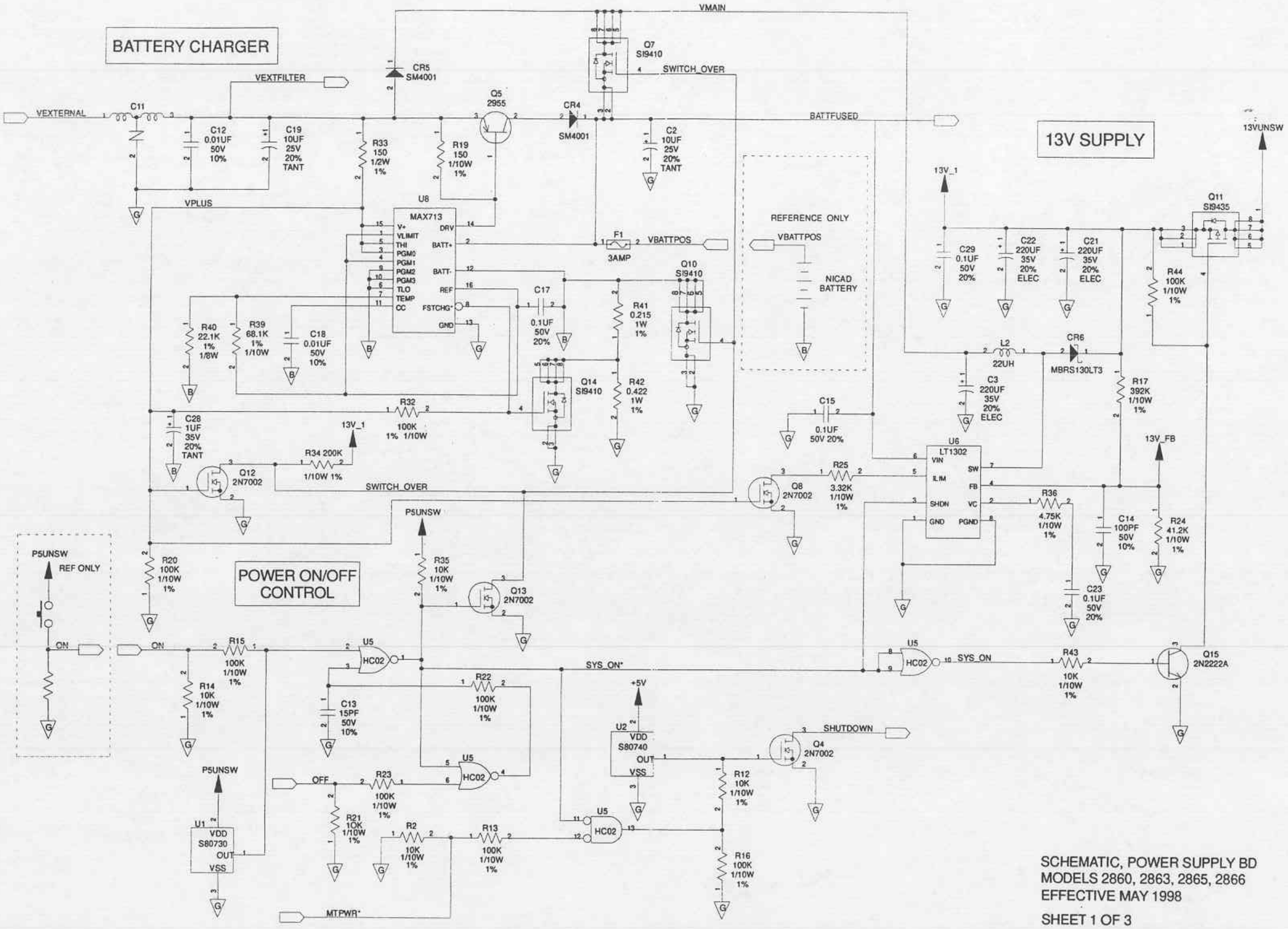
R2
CR1
CR2
CR3
F1
Q2
C5
C6
C7
R4
R5
U2
C3
C4
C9
R9
R13
L1
C8
R17
CR6
R18
U3
CR7
U4
L2
NOT USED
C14
U6
C15
R26
R27
R28
R30
R31
R24
R25
R29
U7
F2 1AMP
Q9
C16
Q8
R37
R36
C23
R38
C21
C22
U9
C26
C27
R44
Q11
C24
C25
Q15
C29
R45
C30
R46
C31
J3
J5


DETAIL A
Capacitor Identification

Electrolytic (acceptable)
Tantalum Chip (not acceptable)

Figure 2 - Board Mounting Modification (Model 2860 with MEA)


EPROM Board Assy.
Power Supply Bd. Assy.
Main Electronics Assy.
2-56 x ¼ Button Head Screw - 2 places (replaces screw used in original assembly)
Insulating Washer - 2 places (used in original assembly)
Nylon Washer - 2 places (added to mounting hardware)


BATTERY CHARGER
13V SUPPLY
POWER ON/OFF CONTROL
REFERENCE ONLY
VBATTPOS
NICAD BATTERY
REF ONLY
P5UNSW
VEXTERNAL
VEXTFILTER
VPLUS
VMAIN
SWITCH_OVER
BATTFUSED
VBATTPOS
13VUNSW
13V_1
13V_FB
SYS_ON*
SYS_ON
SHUTDOWN
ON
OFF
MTPWR*
+5V
C11
C12 0.01UF 50V 10%
C19 10UF 25V 20% TANT
CR5 SM4001
Q5 2955
CR4 SM4001
Q7 SI9410
C2 10UF 25V 20% TANT
R33 150 1/2W 1%
R19 150 1/10W 1%
U8 MAX713
V+ VLIMIT THI PGM0 PGM1 PGM2 PGM3 TLO TEMP CC
DRV BATT+ BATT- REF FSTCHG* GND
F1 3AMP
Q10 SI9410
C17 0.1UF 50V 20%
R41 0.215 1W 1%
R42 0.422 1W 1%
Q14 SI9410
R40 22.1K 1% 1/8W
R39 68.1K 1% 1/10W
C18 0.01UF 50V 10%
R32 100K 1% 1/10W
C28 1UF 35V 20% TANT
Q12 2N7002
R34 200K 1/10W 1%
R20 100K 1/10W 1%
R35 10K 1/10W 1%
Q13 2N7002
R15 100K 1/10W 1%
R14 10K 1/10W 1%
U5 HC02
C13 15PF 50V 10%
R22 100K 1/10W 1%
R23 100K 1/10W 1%
R21 10K 1/10W 1%
R2 10K 1/10W 1%
R13 100K 1/10W 1%
U1 VDD S80730 OUT VSS
U2 VDD S80740 OUT VSS
Q4 2N7002
R12 10K 1/10W 1%
R16 100K 1/10W 1%
C29 0.1UF 50V 20%
C22 220UF 35V 20% ELEC
C21 220UF 35V 20% ELEC
Q11 SI9435
R44 100K 1/10W 1%
L2 22UH
CR6 MBRS130LT3
C3 220UF 35V 20% ELEC
R17 392K 1/10W 1%
C15 0.1UF 50V 20%
U6 LT1302
VIN ILIM SHDN GND SW FB VC PGND
R25 3.32K 1/10W 1%
Q8 2N7002
R36 4.75K 1/10W 1%
C14 100PF 50V 10%
C23 0.1UF 50V 20%
R24 41.2K 1/10W 1%
R43 10K 1/10W 1%
Q15 2N2222A

SCHEMATIC, POWER SUPPLY BD
MODELS 2860, 2863, 2865, 2866
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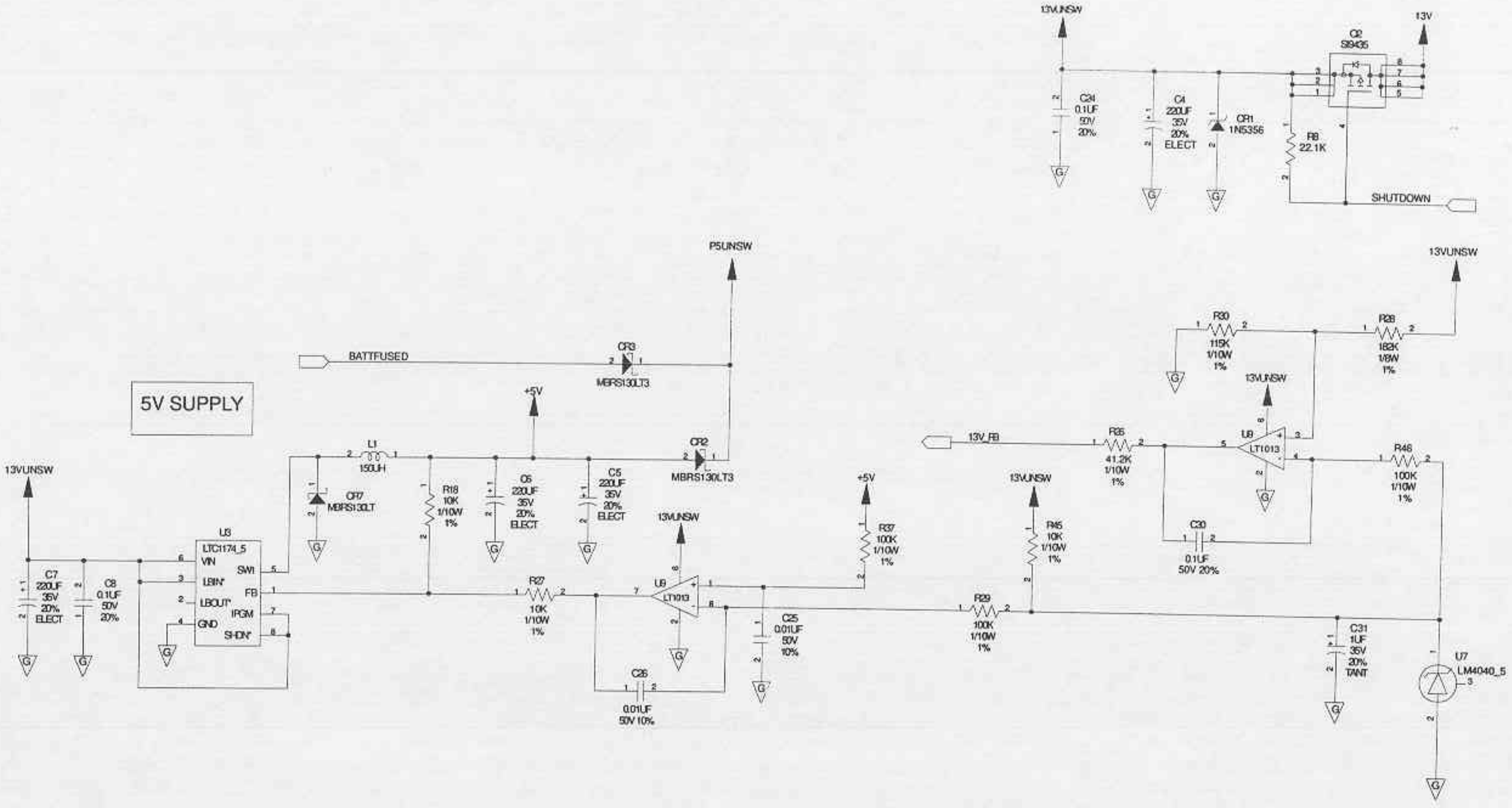
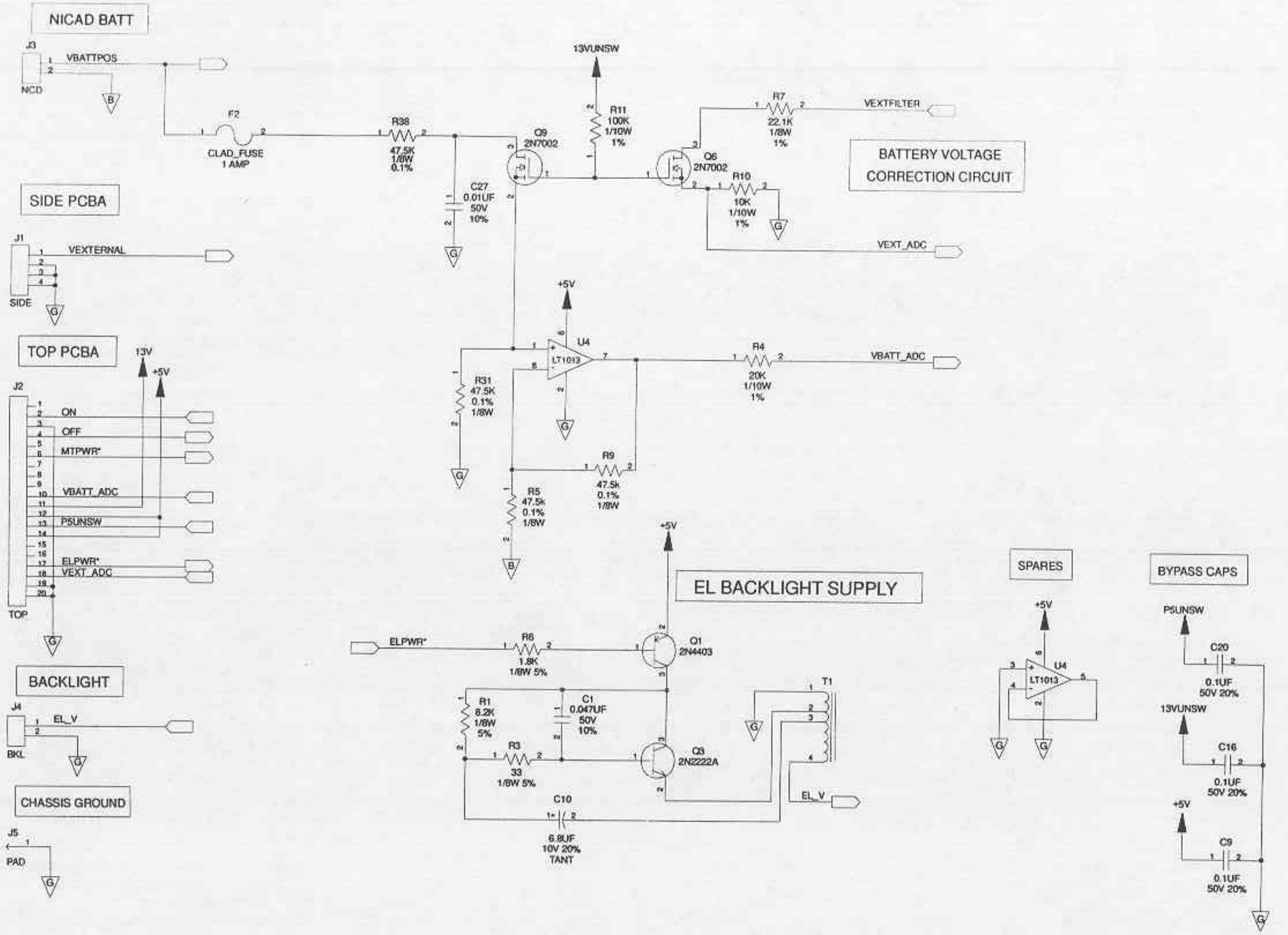
SHEET 1 OF 3


13VUNSW
C24
0.1UF
50V
20%
C4
220UF
35V
20%
ELECT
CR1
1N5356
R8
22.1K
Q2
SI9435
13V
SHUTDOWN
P5UNSW
13VUNSW
BATTFUSED
CR3
MBRS130LT3
5V SUPPLY
+5V
R30
115K
1/10W
1%
R28
182K
1/8W
1%
13VUNSW
13V_FB
R35
41.2K
1/10W
1%
U9
LT1013
R46
100K
1/10W
1%
C30
0.1UF
50V 20%
13VUNSW
L1
150UH
CR2
MBRS130LT3
CR7
MBRS130LT
R18
10K
1/10W
1%
C6
220UF
35V
20%
ELECT
C5
220UF
35V
20%
ELECT
U3
LTC1174_5
VIN
LBIN*
LBOUT*
GND
SW1
FB
IPGM
SHDN*
C7
220UF
35V
20%
ELECT
C8
0.1UF
50V
20%
R27
10K
1/10W
1%
U9
LT1013
13VUNSW
+5V
R37
100K
1/10W
1%
13VUNSW
R45
10K
1/10W
1%
C25
0.01UF
50V
10%
R29
100K
1/10W
1%
C26
0.01UF
50V 10%
C31
1UF
35V
20%
TANT
U7
LM4040_5
G

SCHEMATIC, POWER SUPPLY BD
MODELS 2860, 2863, 2865, 2866
EFFECTIVE MAY 1998

SHEET 2 OF 3


NICAD BATT
J3
VBATTPOS
NCD
F2
CLAD_FUSE
1 AMP
R38
47.5K
1/8W
0.1%
C27
0.01UF
50V
10%
Q9
2N7002
13VUNSW
R11
100K
1/10W
1%
Q6
2N7002
R7
22.1K
1/8W
1%
VEXTFILTER
R10
10K
1/10W
1%
VEXT_ADC
BATTERY VOLTAGE
CORRECTION CIRCUIT
SIDE PCBA
J1
VEXTERNAL
SIDE
TOP PCBA
13V
+5V
J2
ON
OFF
MTPWR*
VBATT_ADC
P5UNSW
ELPWR*
VEXT_ADC
TOP
+5V
U4
LT1013
R31
47.5K
0.1%
1/8W
R4
20K
1/10W
1%
VBATT_ADC
R9
47.5k
0.1%
1/8W
R5
47.5k
0.1%
1/8W
BACKLIGHT
J4
EL_V
BKL
CHASSIS GROUND
J5
PAD
EL BACKLIGHT SUPPLY
+5V
ELPWR*
R6
1.8K
1/8W 5%
Q1
2N4403
R1
8.2K
1/8W
5%
C1
0.047UF
50V
10%
R3
33
1/8W 5%
Q3
2N2222A
T1
EL_V
C10
6.8UF
10V 20%
TANT
SPARES
+5V
U4
LT1013
BYPASS CAPS
P5UNSW
C20
0.1UF
50V 20%
13VUNSW
C16
0.1UF
50V 20%
+5V
C9
0.1UF
50V 20%
B
G

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SHEET 3 OF 3

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Service Bulletin 424

P/N 142513A

Service Bulletins are supplements to ALARIS Medical's Technical Service/Maintenance Manuals.

Model Affected: MedSystem III™ Multi-Channel Infusion Pump, Model 2860
Date: December 1997
Subject: Logic Board Assembly

Purpose

The purpose of this bulletin is to provide Biomedical Technicians information related to the release of an ASIC Logic Board Assembly for the Model 2860.

Explanation

The Model 2860 Main Electronics Assembly (MEA), P/N 2860679, listed in the *Recommended Spare Parts* section in *Appendix C* of the current service manual, is a "reconditioned" assembly. A limited quantity of the MEA is available for reconditioning, and once the existing inventory of the "reconditioned" MEA is depleted it will no longer be available. A "new build" board assembly, which is an ASIC logic board assembly (U28 and U29 are 100 pin ASIC components), is now available. When replacing a MEA with an ASIC logic board assembly the software (EPROM module) will need to be updated, the board mounting requirements may change, and there may be some changes to the user interface. The replacement board assembly kit will include the necessary parts and installation instructions.

References

Model 2860/2863 Technical Service Manual (*identified as P/N 139981, ordered as P/N 2863012*)
Service Bulletin 391 (*or more current*), Logic Board Schematic

Parts and Tools Required

Reference the appropriate sections of the service manual if servicing becomes necessary.

Recommended Action

Refer to the following information when replacing a Model 2860 MEA or ASIC Logic Board Assembly.

1. Board Assembly Part Numbers

WHEN REPLACING:	ORDER: P/N	DESCRIPTION
MEA, Software Rev. 3.3	142594	Logic Board Kit, Software Rev. 3.5 (Consists of logic board assembly, top board pad, mounting pads, cable tie, directions for use, Rev. 3.5 EPROM module, installation instructions.)
MEA, Software Rev. 4.0 or 5.0	142593	Logic Board Kit, Software Rev. 5.0 (Consists of logic board assembly, top board pad, mounting pads, cable tie, Rev. 5.0 EPROM module, installation instructions.)
ASIC Logic Brd. Assy., Software Rev. 3.5 or 5.0	142595	Logic Board Assembly

2. Functional and User Interface Changes

   a. When the Rev. 4.0 or 5.0 software used with the MEA is updated to Rev. 5.0 for the ASIC logic board assembly there will be no functional or user interface changes.

   b. When the Rev. 3.3 software used with the MEA is updated to Rev. 3.5 for the ASIC logic board assembly there will be no functional changes to the instrument's operation, but there will be the following user interface changes.

	Revision 3.3	Revision 3.5
View softkey ↓ **Cntrst**	Pressing **View** changes background lighting from dimmest to brightest. "Wrap around" function in place.	Softkey changed to **Cntrst** (contrast). No "wrap around" function. Prompt line provides a visual indicator of the lighting display intensity.
Instrument **TotVol** (sum of all 3 channels)	User can set a Total Volume Limit.	Setting a Total Volume Limit is not available.
Air in lower tubing	**ClrAir** (clear air) softkey available.	No **ClrAir** (clear air) softkey available.
VR=0 advisory when rate is less than KVO rate.	For **VR=0** advisory, when the rate is less than the programmed KVO rate, status line reads "**Infusing**".	For **VR=0** advisory, when the rate is less than the programmed KVO rate, status line reads "**KVO**".

3. Logic Board Assembly Schematic

The schematic for the Model 2860 ASIC logic board assembly is the same as for the Model 2863 board assembly (*reference Service Bulletin 391*).

NOTE: The only difference between the Model 2860 and 2863 ASIC logic board assemblies is the air-in-line connectors (S4, S5, S6).

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Service Bulletin 431

P/N 143187A

Service Bulletins are supplements to ALARIS Medical Technical Service/Maintenance Manuals.

Model Affected: MedSystem III® Multi-Channel Infusion Pump, Model 2866
Date: November 1998
Subject: Release of Model 2866

Purpose

The purpose of this bulletin is to provide Biomedical Technicians information related to the release of the Model 2866 English UK, French, and German configurations.

Explanation

The Model 2866 is a 220V version of the MedSystem III Multi-Channel Infusion Pump, and is functionally equivalent to the Model 2863. Various parts were released/updated with the release of the Model 2866, as follows:

Part	Differences
AC Adapter	---- Model 1556A for United Kingdom, and Model 1557A for other 220V countries
DFUs, Labels	---- French and German languages, AC Adapter references, and 220V references
Keypad Assembly	---- improvement to ground strip changes fold requirements for strip when installing keypad
Power Supply Bd. Assy.	---- ferrite bead added to side cable
Side Board Assy. (Audio/Connector PCBA)	---- side board has not changed, but use of flat washers when installing board assembly eliminates need for silicone sealant
Programmed EPROM	---- Rev. 5.11 (English UK), Rev. 5.33 (French), Rev. 5.22 (German)

References

Model 2860/2863 Technical Service Manual (*identified as P/N 139981, ordered as P/N 2863012*)
Service Bulletin 404A (*or more current*), Level of Testing Guidelines

Parts and Tools Required

Reference the appropriate sections of the service manual if servicing becomes necessary.

Recommended Action

Include the attached information, as a service manual reference, when repairing a Model 2866 instrument.

Keypad Assembly (*Supplement to Repair chapter of service manual*)

Use the following procedure when replacing the keypad assembly. Use the *Repair* chapter of the service manual to disassemble and reassemble the instrument in the following steps.

CAUTION

> *Turn the instrument off and disconnect it from AC power before disassembly. Static charges will damage instrument circuitry. Observe proper grounding techniques (use grounding strap) to prevent possible harm to static-sensitive components.*

1. Disassemble the instrument.
    a. Remove the battery pack.
    b. Remove the lower housing assembly.
    c. Remove the main housing assembly from the chassis assembly.
2. Remove the keypad assembly.
    a. Remove the conductive grounding tape, located inside the main housing behind the ON/OFF switch. Peel off the tape, using care to avoid scratching the special conductive coating on the main housing.
    b. Peel the ground strip (part of the keypad assembly) loose from the main housing.
    c. If a foam pad is installed behind the connector cable (part of the keypad assembly), peel the cable loose from the pad. If the foam pad is damaged or has lost its adhesive strength, remove the pad from the housing.
    d. Peel the keypad from the main housing. Discard the old keypad assembly.
    e. Using a rubbing motion or an oil-free label adhesive remover, remove any residual adhesive from the main housing. Make sure that the keypad recess on the main housing is free of dirt and oil.
3. Install the new keypad assembly. (*See figures 1 and 2*)
    a. Remove the protective sheet from the screen of the new keypad assembly.
    b. Bend the ground strip and connector cable perpendicular to the keypad.
    c. Remove the top half of the keypad adhesive backing.
    d. Insert the ground strip and connector cable through the slots in the main housing.
    e. Align the top edge of the keypad with the top edge of the recess in the main housing, and position so as to leave no space between the top of the keypad and the recess.
    f. Remove the rest of the adhesive backing from the keypad and evenly press the keypad onto the main housing.

Keypad Assembly (*Supplement to Repair chapter of service manual*) (Continued)

a. Remove the adhesive backing from the ground strip.

b. Fold the ground strip, where marked with notches, toward the adhesive strip. (*See view B of figure 2*)

c. Bend the folded ground strip up and secure it flat against the inside of the main housing. (*See view B of figure 2*)

d. Apply the conductive tape (provided with the keypad) across the ground strip, aligning the tape just below the top rib of the housing.

e. If a foam pad is not already installed on the housing behind the connector cable:

Remove the adhesive backing from one side of the new foam pad (provided with the keypad) and adhere the pad to the housing, positioning it behind the connector cable and aligning it against the mounting bracket and the top rib of the housing. Remove the remaining adhesive backing from the foam pad.

l. Bend the connector cable up and secure it to the foam pad, bending the top portion of the cable to a 90° angle, just below the top rib of the housing. (*See view A of figure 2*)

NOTE: The recommended adhesive cure time for the keypad is 48 hours.

4. Reassemble the instrument.
   a. Install the main housing assembly onto the chassis assembly.
   b. Install the battery pack.
   c. Install the lower housing assembly.
5. Verify the memory contents and restore if necessary. (*Reference Field Maintenance Software Manual, as appropriate for FMS software version in use.*)
   a. Turn the instrument on. If the calibration parameters have been corrupted, the self-tests will produce a fault alarm, indicating that calibration is required.
   b. Verify that the customized settings are correct.
   c. Verify that the Battery History Log information has not been corrupted.
6. Test the instrument. (*Reference Systems Functional Tests chapter of service manual.*)
   a. Perform Electrical Safety Test.
   b. Perform Power Tests.
   c. Perform Watchdog Audio Test.

Figure 1 - Keypad Installation

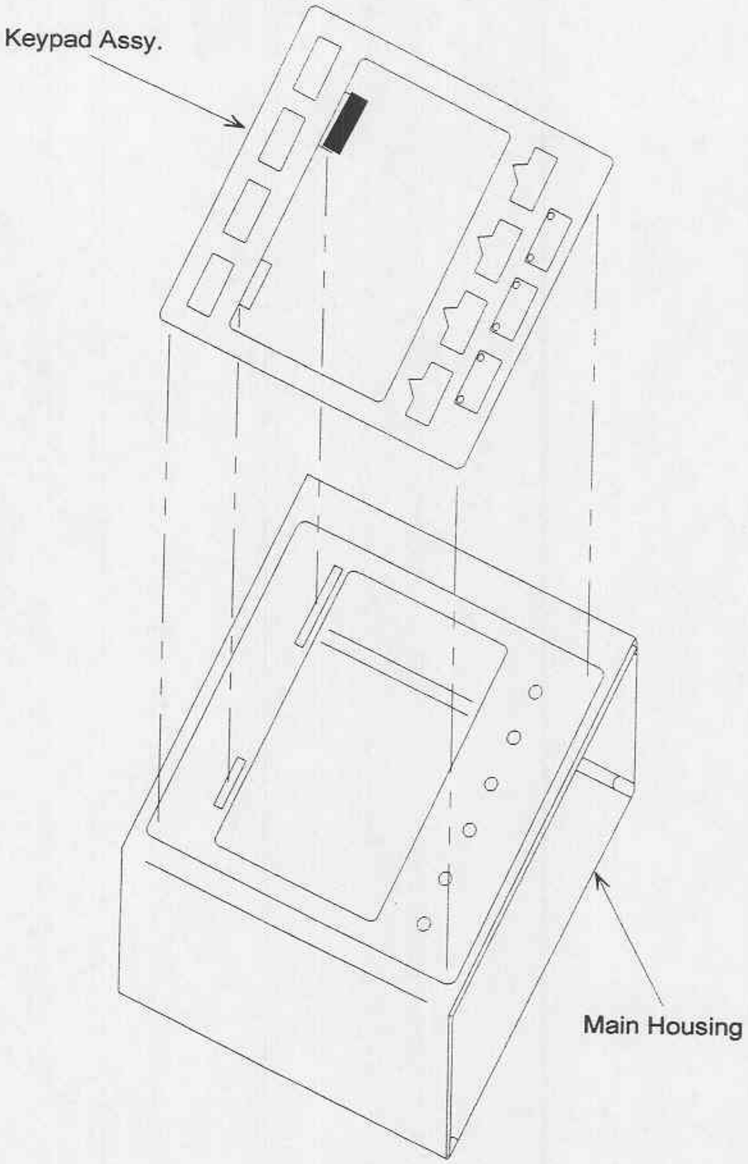
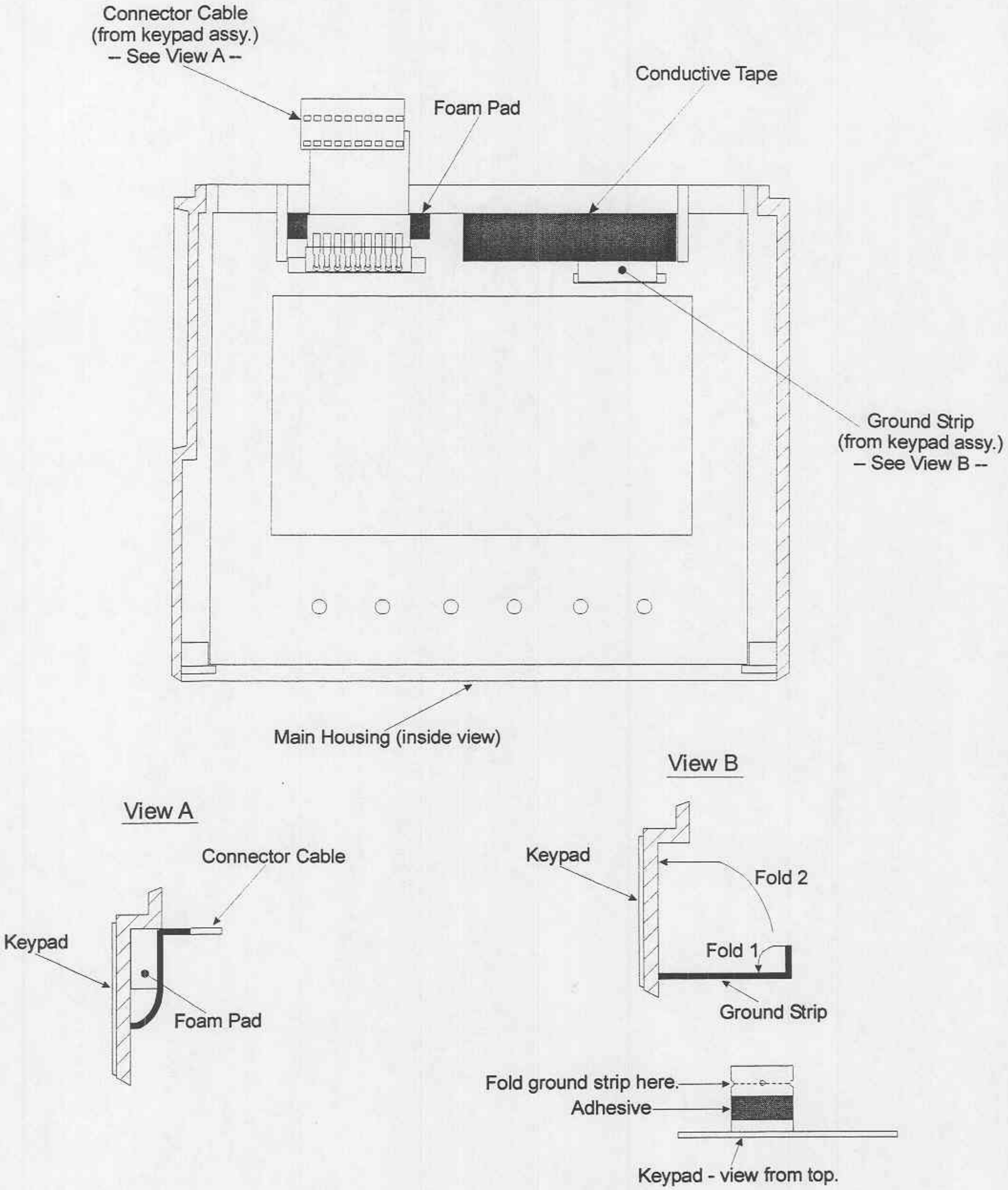

Keypad Assy.
Main Housing

Figure 2 - Ground strip and connector cable positioned and secured.


Connector Cable
(from keypad assy.)
-- See View A --
Conductive Tape
Foam Pad
Ground Strip
(from keypad assy.)
-- See View B --
Main Housing (inside view)
View B
View A
Connector Cable
Keypad
Keypad
Fold 2
Fold 1
Foam Pad
Ground Strip
Fold ground strip here.
Adhesive
Keypad - view from top.

Power Supply Board Assembly (*Supplement to Repair chapter of service manual*)

Use the following procedure when removing and installing a power supply board assembly.

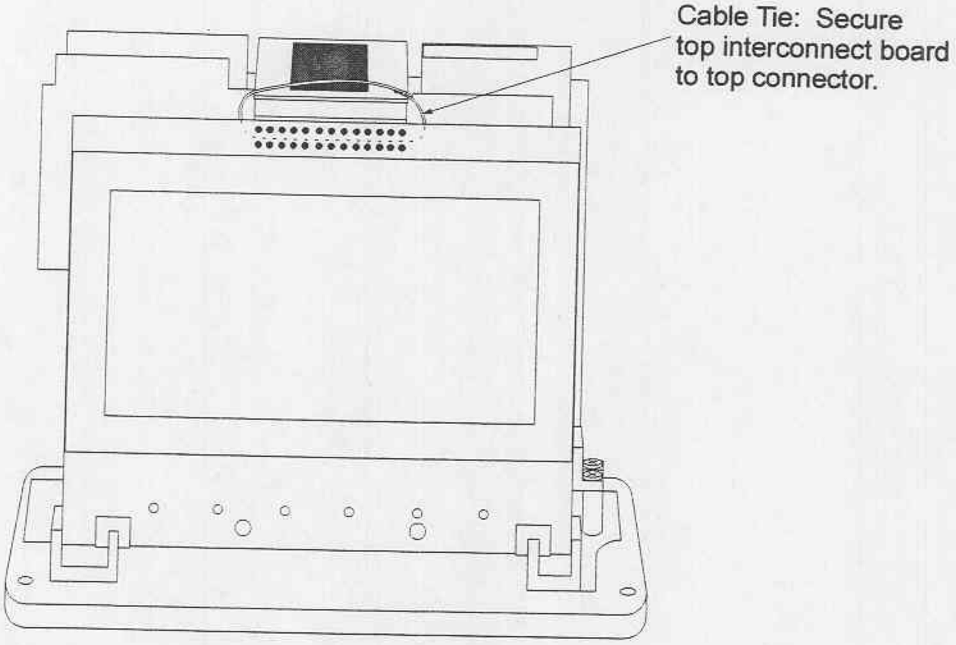
CAUTION

> *Turn the instrument off and disconnect it from AC power before disassembly. Static charges will damage instrument circuitry. Observe proper grounding techniques (use grounding strap) to prevent possible harm to static-sensitive components.*

1. Disassemble the instrument and remove the power supply board assembly per the *Power Supply PCBA Disassembly* section in the *Repair* chapter of the service manual.
2. Install the power supply board assembly per the *Power Supply PCBA Reassembly* section in the *Repair* chapter of the service manual.

   NOTE: As the board assembly is being installed, route the side cable (J1) between the power supply board assembly and the side board assembly, being careful to avoid an interference fit with the ferrite bead on the cable.
3. Install the display module. (*Reference Display Module Reassembly section in Repair chapter of service manual.*)
4. Slide a self locking cable tie (*reference Appendix C in Appendices chapter of service manual for Cable Tie Kit part number*) between the double row header pins of the top connector on the display module, and over the top interconnect board. Tighten the cable to secure the top interconnect board to the top connector of the display module. (*See figure 3*)

Figure 3 - Cable Tie Installation



Power Supply Board Assembly (*Supplement to Repair chapter of service manual*) (Continued)

5. Complete assembly of the instrument per the *Power Supply PCBA Reassembly* section in the *Repair* chapter of the service manual.
6. Verify the memory contents and restore if necessary. (*Reference Field Maintenance Software Manual, as appropriate for FMS software version in use.*)
    a. Turn the instrument on. If the calibration parameters have been corrupted, the self-tests will produce a fault alarm, indicating that calibration is required.
    b. Verify that the customized settings are correct.
    c. Verify that the Battery History Log information has not been corrupted.
7. Test the instrument. (*Reference Systems Functional Tests chapter of service manual, and current version of Service Bulletin 404.*)

Side Board Assembly (*Supplement to Repair chapter of service manual*)

Use the following procedure when removing and installing a side board assembly.

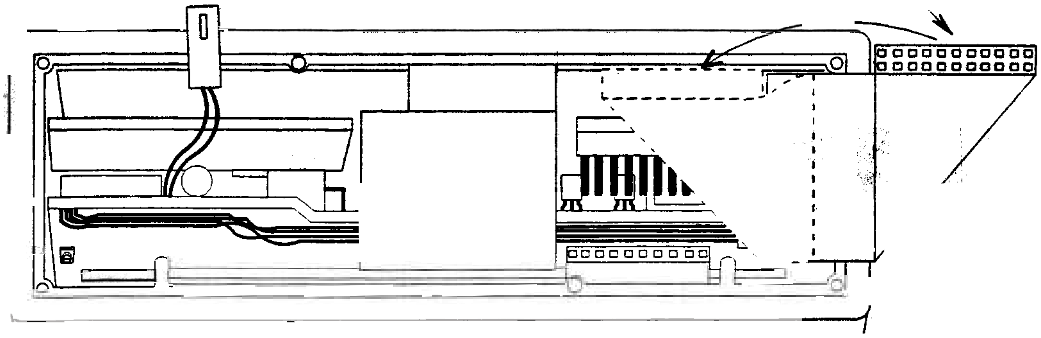
CAUTION

Turn the instrument off and disconnect it from AC power before disassembly. Static charges will damage instrument circuitry. Observe proper grounding techniques (use grounding strap) to prevent possible harm to static-sensitive components.

1. Disassemble the instrument and remove the side board assembly per the *Audio/Connector PCBA and Label Replacement* section in the *Repair* chapter of the service manual.
2. Install the side board assembly per the *Audio/Connector PCBA and Label Replacement* section in the *Repair* chapter of the service manual, with the following differences:
   a. Place a flat washer (removed during disassembly) on each of the two socket connectors on the new side board assembly.
   b. Do not seal the gap between the housing and the connectors with silicone sealant.
   NOTE: The use of a flat washer eliminates the need for sealant.
   c. Ensure that the cable is properly folded. (*See figure 4*)

Figure 4 - Side Board Cable Fold

Fold and connect side board cable as shown.



Side Board Assembly (*Supplement to Repair chapter of service manual*) (Continued)

3. Reassemble the instrument per the *Audio/Connector PCBA and Label Replacement* section in the *Repair* chapter of the service manual.
4. Test the instrument. (*Reference Systems Functional Tests chapter of service manual, and current version of Service Bulletin 404.*)

Parts Breakdown (*Supplement to Appendices chapter of service manual*)

Use the following information when ordering any of the listed parts for the Model 2866. Part numbers not listed below remain the same as for a Model 2863.

Part Number	Description
	AC Adapter Kit, Locking (Consists of AC Adapter, retaining ring, and installation instructions.)
143032	Model 1556A (UK)
143450	Model 1557A (all except UK)
	EPROM Assembly
143366	English UK (Rev. 5.12)
143452	French (Rev. 5.33)
143451	German (Rev. 5.22)
	Housing Assembly, Partial Main (Labeled housing with keypad attached.)
143009	English UK
143454	French
143453	German
	Keypad Kit (Consists of keypad, foam pad, kapton tape, and installation instructions.)
143010	English
143462	French
143461	German
143013	Power Supply Board Kit (Consists of power supply board assembly and installation instructions.)
142773	Side Board Assembly

Labels/Literature:

142614	ALARIS Logo Label
	Directions for Use
143365	English UK
142522	French
142521	German
	DRC Label
140359	English
142914	French
142906	German
	Connector Label
136840	English
142909	French
142901	German
	Rear Label
143014	English UK
143457	French
143455	German

Parts Breakdown (*Supplement to Appendices chapter of service manual*) (Continued)

Labels: (Continued)

Part Number	Description
	Start-Up Label
139935	English
142912	French
142904	German
	Label Kit (Consists of connector label, rear label, start-up label, and DRC label.)
None	English UK
143460	French
143459	German

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Service Bulletin 435

P/N 143807A

Service Bulletins are supplements to ALARIS Medical Technical Service/Maintenance Manuals.

Model Affected: MedSystem III® Multi-Channel Infusion Pump, Model 2865
Date: March 1999
Subject: Release of Model 2865

Purpose

The purpose of this bulletin is to provide Biomedical Technicians information related to the release of the Model 2865.

Explanation

The Model 2865 is functionally equivalent to the Model 2863, with the exception that the Model 2865 has a Drug List Editor (DLE) feature. DLE is a software program that is loaded onto a PC, where it is used to create a custom drug library which can be downloaded from the PC to the Model 2865. The DLE and FMS (Field Maintenance Software) are provided separate from the instrument.

Various parts were released/updated with the release of the Model 2865, as follows:

Part	Differences
Connector Label, and DRC Label	--- text/background colors
Directions for Use	--- DLE related directions provided
Keypad Assembly	--- word "RECHARGE" not on "ON/OFF" switch
Rear Label	--- AC adapter statement repeated in French. CSA statement not present (made part of a separate label).
Start-Up Procedure Label	--- set usage statement references 28 Series only (25 Series reference removed)

References

Model 2860/2863 Technical Service Manual (*identified as P/N 139981, ordered as P/N 2863012*)

Parts and Tools Required

Reference the appropriate sections of the service manual if servicing becomes necessary.

Recommended Action

Include the attached information, as a service manual reference, when repairing a Model 2865 instrument.

Parts Ordering: Refer to Illustrated Parts Breakdown chapter of the Technical Service/Maintenance Manual
Technical Inquiries. 1-800-854-7128, 1-619-458-6003, FAX 1-619-458-7507

Parts Breakdown (*Supplement to Appendices chapter of service manual*)

Use the following information when ordering any of the listed parts for the Model 2865. Part numbers not listed below remain the same as for a Model 2863.

NOTE: The side board assembly listed below for the Model 2865 is the same board assembly provided in the kit currently being used for the Model 2863. The only difference is that the Model 2863 side board assembly kit includes additional parts that are not required when the board assembly is installed into a Model 2865.

Part Number	Description
143816	Housing Assembly, Partial Main, English (Labeled housing with keypad attached.)
143817	Keypad Kit, English (Consists of keypad, foam pad, kapton tape, and installation instructions.)
142773	Side Board Assembly

Labels/Literature:

142614	ALARIS Logo Label
143731	Connector Label, English
	Directions for Use, English
143685	DLE
140799	FMS
143554	Instrument
143694	DRC Label, English
143818	Label Kit, English/French (Consists of connector label, rear label, start-up label, and DRC label.)
143703	Rear Label, English
143704	Start-Up Label, English

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Service Bulletin 439

P/N 144517A

Service Bulletins are supplements to ALARIS Medical Technical Service/Maintenance Manuals.

Model Affected: MedSystem III® Multi-Channel Infusion Pump, 286X Series
Date: March 1999
Subject: ESD Handling Requirements and Cautions

Purpose

The purpose of this bulletin is to provide a single reference for the electrostatic discharge (ESD) handling requirements and cautions.

Explanation

The MedSystem III (286X Series) instruments are designed to withstand typical environmental conditions encountered during normal use, including electromagnetic interference, mechanical shock, and temperature extremes. The electronic components used in the MedSystem III instrument, however, can be damaged by electrostatic discharges (ESD). Whenever the instrument case is opened, for any reason, special handling procedures and precautions must be followed to ensure that electronic components in the instrument are not damaged by electrostatic discharges.

References

Model 2860/2863 Technical Service Manual (*identified as P/N 139981, ordered as P/N 2863012*)

Parts and Tools Required

Reference the appropriate sections of the service manual if servicing becomes necessary.

Recommended Action

The instrument case should only be opened by qualified service personnel. The electronic components used in the MedSystem III instrument can be damaged by electrostatic discharges (ESD). Always use proper grounding techniques and handling procedures, as outlined below, whenever the instrument is opened (for any reason), or when handling electronic components or assemblies.

1 Store printed circuit board assemblies and transducers in their conductive packaging until ready for use.

2. Wear a 0.5 to 1.5 megohm wrist strap for grounding.

3. Ensure that the work stations have grounded conductive mats or surfaces.

4. All conductive surfaces and equipment must be connected to earth ground.

5. When handling electronic or sensor assemblies, wear clothes that do not generate static.

6. Handle all printed circuit board assemblies by the edges.

7 Ideally, room humidity should be kept between 45% and 60%, because static electricity increases as humidity decreases.

8. Periodically check the grounding point and wrist strap continuity.

NOTE: For further details on ESD protection refer to DoD Handbook 263 and DoD Standard 1686.

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Service Bulletin 445

P/N 144632A

Service Bulletins are supplements to ALARIS Medical Technical Service/Maintenance Manuals.

Model Affected: MedSystem III® Multi-Channel Infusion Pump, 2860
Date: April 1999
Subject: Dark LCD Display

Purpose

The purpose of this bulletin is to provide Biomedical Technicians a ***Troubleshooting tip*** for a dark LCD display.

Explanation

When installing a new LCD display module in a Model 2860, the display may be too dark, even with the contrast adjustment at the lightest setting. This is due to a difference in drive requirements between the latest version of the LCD display and the earlier display.

References

Model 2860/2863 Technical Service Manual (*identified as P/N 139981, ordered as P/N 2863012*)

Parts and Tools Required

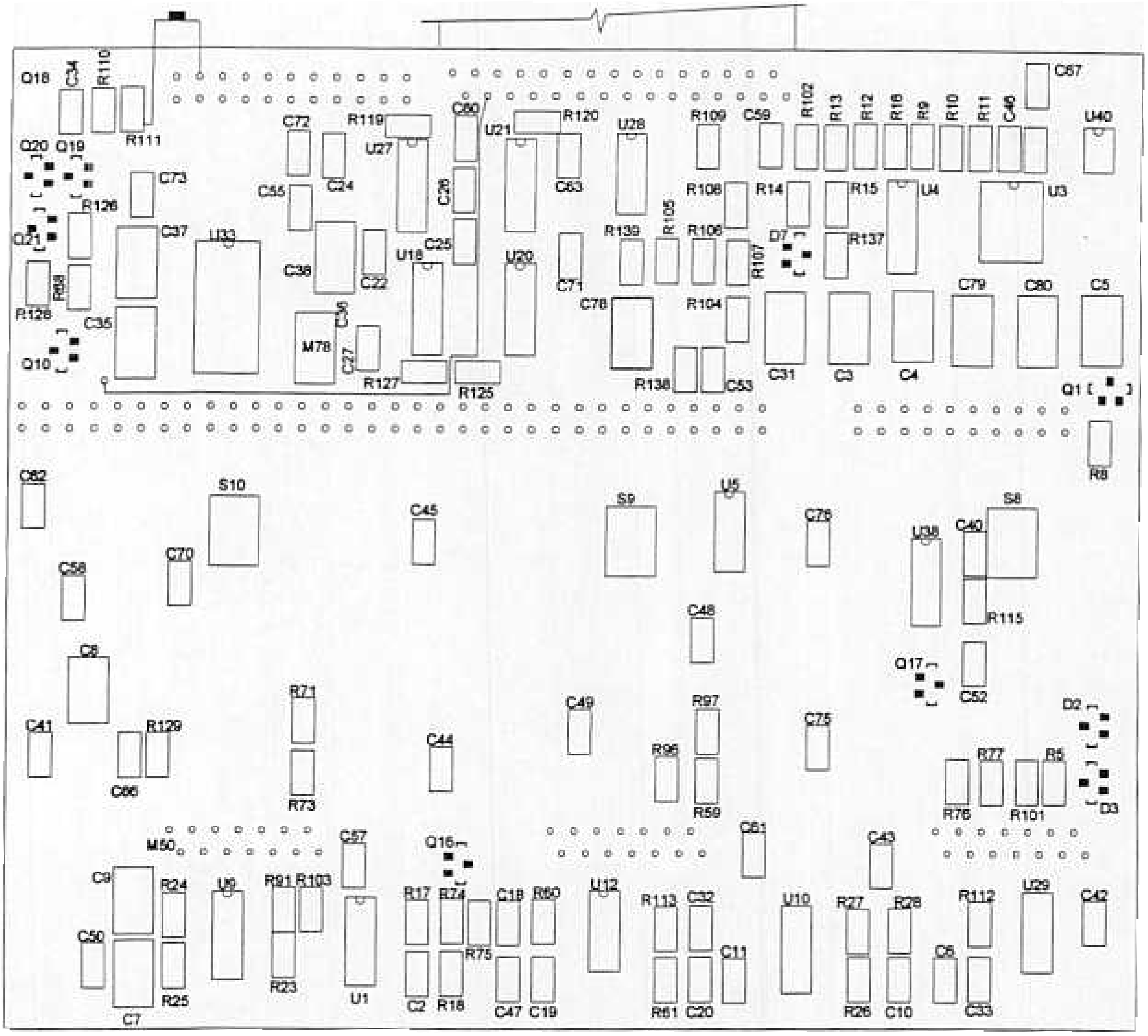
Reference the appropriate sections of the service manual if servicing becomes necessary.

Recommended Action

When a new LCD display module has been installed in a Model 2860 and the display contrast is considered to be too dark, it is recommended that the instrument be returned to ALARIS Medical Systems for modification.

Figure 1 - SMT Board Assembly (component location reference)

NOTE: If the board assembly has been modified to address a dark display problem, R15 will be 150 ohms and R137 will be 8.2K ohms


Q18
C34
R110
R111
C72
R119
C60
U21
R120
U28
R109
C59
R102
R13
R12
R16
R9
R10
R11
C46
C67
U40
Q20
Q19
U27
C73
C55
C24
C26
C63
R108
R14
R15
U4
U3
R126
C37
U33
C25
U18
U20
R139
R105
R106
D7
R137
Q21
R58
C38
C22
C71
R107
C79
C80
C5
R128
C35
C36
M78
C78
R104
C27
Q10
R127
R125
R138
C53
C31
C3
C4
Q1
R8
C82
S10
C45
S9
U5
C76
U38
C40
S8
C58
C70
R115
C48
C8
Q17
C52
C41
R71
C49
R97
R129
C44
R96
C75
D2
R77
R5
C66
R73
R59
R76
R101
D3
C57
Q16
C61
C43
M50
C9
R24
U9
R91
R103
R17
R74
C18
R60
U12
R113
C32
U10
R27
R28
R112
U29
C42
C50
R75
C11
C6
R25
R23
U1
C2
R18
C47
C19
R61
C20
R26
C10
C33
C7

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Service Bulletin 454A

P/N 145056A

Service Bulletins are supplements to ALARIS Medical Technical Service/Maintenance Manuals.

Models Affected: MedSystem III® Multi-Channel Infusion Pump; 2860, 2863
Date: July 1999
Subject: Memory Backup Batteries

☞ *This supersedes Service Bulletin 454, to remove "(ground)" to describe the red lead.*

Purpose

The purpose of this bulletin is to provide Biomedical Technicians information about an upgraded memory backup battery for Models 2860 and 2863.

Explanation

Model 2860 and 2863 instruments must have the upgraded version of the lithium backup battery assembly installed to ensure current UL 1642 requirements are met. The upgraded backup battery assembly has been available since June 1996, and Model 2863B instruments built after June 1996 will meet the current UL 1642 requirements.

References

Model 2860/2863 Technical Service Manual (*identified as P/N 139981, ordered as P/N 2863012*)
Service Bulletin 439 (*or more current*), ESD Handling Requirements and Cautions

Parts and Tools Required

Reference the appropriate sections of the service manual if servicing becomes necessary.

Recommended Action

CAUTION

Turn the instrument off and disconnect it from AC power before disassembly. Static charges will damage instrument circuitry. Observe proper grounding techniques (use grounding strap) to prevent possible harm to static-sensitive components. Reference current version of Service Bulletin 439.

1. To determine which version of the backup battery assembly is installed, disassemble the instrument to allow access to the backup batteries. (*Reference Backup Battery Replacement section in Repair chapter of service manual.*)
2. The upgraded version of the backup batteries, that meet current UL 1642 requirements, can be easily identified by having a diode installed. The diode will be visible beneath the shrink-wrap and installed in series with the red lead.
3. The new backup battery assembly can be ordered as part number 2860729.

Parts Ordering: Refer to Illustrated Parts Breakdown chapter of the Technical Service/Maintenance Manual
Technical Inquiries: 1-800-854-7128, 1-619-458-6003, FAX 1-619-458-7507

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Service Bulletin 455

P/N 145039A

Service Bulletins are supplements to ALARIS Medical Technical Service/Maintenance Manuals.

Model Affected: MedSystem III® Multi-Channel Infusion Pump – 2860, 2863, 2865, 2866
Date: October 1999
Subject: Rate Accuracy Specification

Purpose

The purpose of this bulletin is to inform Biomedical Technicians of an update to the accuracy specification for Models 2860, 2863, 2865, and 2866.

Explanation

The specifications contained in this bulletin replace the Flow Accuracy Conditions statement in the *System Specifications* section in *Appendix A* of the MedSystem III Technical Service Manual.

References

Model 2860/2863 Technical Service Manual (*identified as P/N 139981, ordered as P/N 2863012*)

Parts and Tools Required

Not applicable.

Recommended Action

Use the following specification in place of the corresponding information in the service manual. Refer to the service manual for all other specifications.

System Specifications

Rate Accuracy: 1.0 – 999 ml/hr ±5% with a standard deviation of 1.96 under specified conditions. (*See Note*)

0.1 – 0.9 ml/hr ±10% with a standard deviation of 1.96.

NOTE: Long term accuracy specified, per IEC 60601-2-24, under the following conditions:

Head height: 30 in/76.2 cm
Test solution: distilled water
Environmental: ambient temperature
Back pressure: 18 gauge needle
IV set: Model 28034

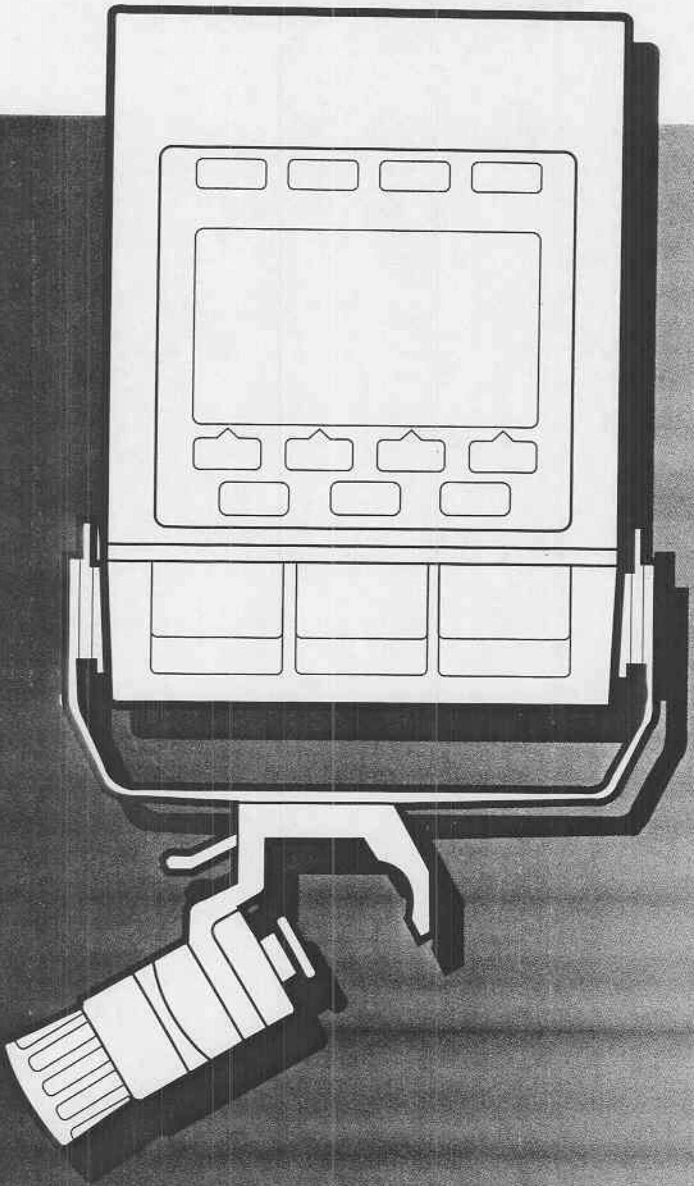
Parts Ordering: Refer to Illustrated Parts Breakdown chapter of the Technical Service/Maintenance Manual
Technical Inquiries: 1-800-854-7128, 1-858-458-6003, FAX 1-858-458-7507

MedSystem III™

Multi-Channel Infusion Pump

Models 2860

Version 3.3d



DIRECTIONS FOR USE

IVAC®

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1.0 Introduction of the MedSystem III™ Multi-Channel Infusion Pump

The MedSystem III Multi-Channel Infusion Pump (Figure 1-1) is a programmable fluid delivery system consisting of three separate channels. Since it is less than one quarter the size and weight of a standard single-channel intravenous (IV) pump, it is extremely convenient to use.

The MedSystem III Pump can be configured for several different Device Types, including the following:

- General Purpose
- Neonatal
- Controller Pressure
- Operating Room
- General Purpose II
- Operating Room II

The MedSystem III Pump delivers a variety of fluids and can be used for intravenous, intra-arterial, and subcutaneous applications.

The MedSystem III Pump continuously monitors its own performance. If a problem occurs, the system issues an alarm for the affected channel or for the pump as a whole.

The MedSystem III Pump is intended for use with IVAC 28 or 25 series sets. These sets contain a cassette which allows the pump to infuse fluid from syringes, bottles, and bags, even if the container is located below the level of the pump.

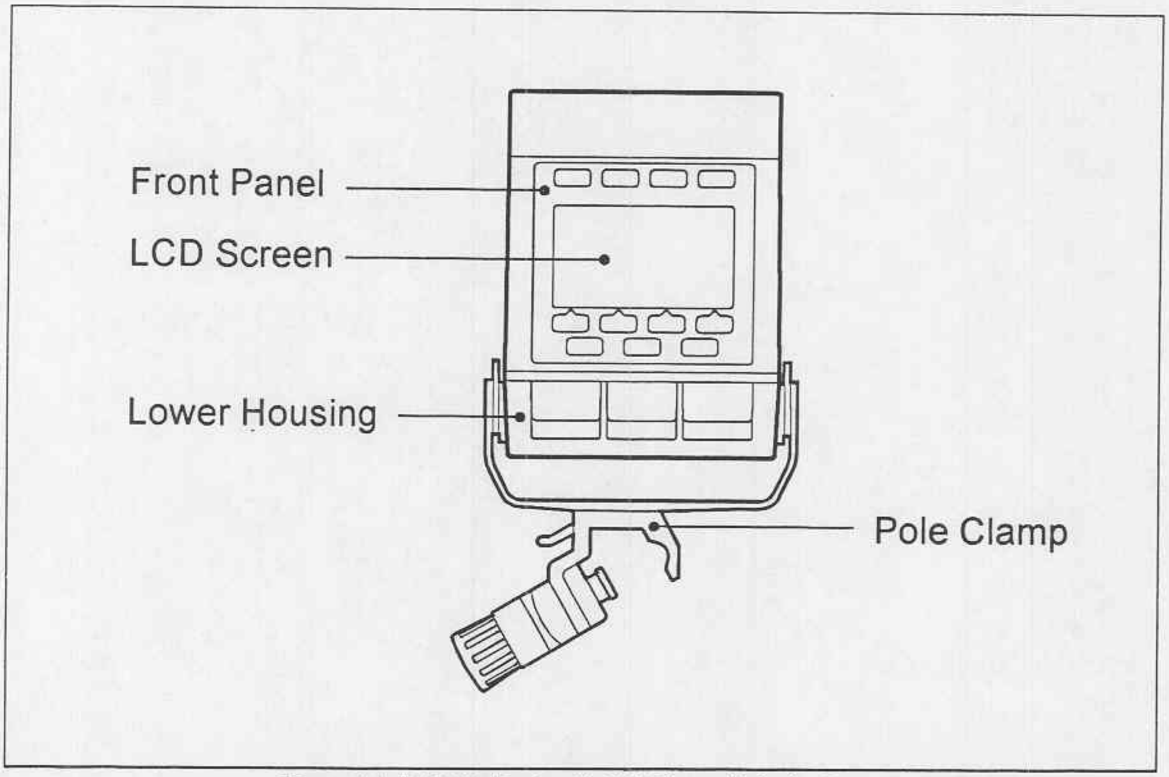


Figure 1-1: IVAC MedSystem III Multi-Channel Infusion Pump

1.1 Features

- Multi-Channel Fluid Delivery
  The MedSystem III Multi-Channel Infusion Pump is three pumps in one. It has three separate, independently programmable infusion channels. As a replacement for three large IV pumps, it can save both time and money, as well as minimize clutter around a patient's bed.

- Small Size
  The MedSystem III Pump is ideal for any application where rapid access to the patient and/or easier patient transport is desirable (e.g., intensive care, air ambulance, in-hospital chemotherapy, neonatal ICU, operating room, etc.).

- Light Weight
  The MedSystem III Pump weighs only about 5.2 lb. (with Pole Clamp attached) and is easy to transport. It eliminates the inconvenience of having to manipulate three separate pumps with a potential combined weight of over 30 lb.

- Wide Range of Delivery Rates
  The MedSystem III Pump is capable of delivering fluids at flow rates from 0.1 ml/h to 999 ml/h per channel.

- Administration Set
  The IVAC sets contain a cassette that minimizes unrestricted flow when removed from the pump, yet allows gravity flow when needed. There is also an air trap within the cassette which traps air flowing through the tubing and reduces nuisance air-in-line alarms.

- Battery Capacity
  The batteries of the pump allow approximately 6 to 8 hours of operating time from full charge to the Depleted Battery alarm, with each individual channel running at a rate of 125 ml/h. If the MedSystem III Pump is operating on batteries (DC power) and no cassette is installed, the pump will shut itself off 5 minutes after the last key was pressed.

- Alarm System
  The alarm system provides both audio and visual alarms and advisories to alert the operator to a variety of individual channel or pump conditions.

- Clinical Device Types
  The MedSystem III Pump can be programmed to six clinical Device Types: General Purpose, Neonatal, Controller Pressure, Operating Room, General Purpose II, and Operating Room II.

  Each of these Device Types has a different set of default parameters appropriate for its specific applications. In addition, parameters for each Device Type can be customized to fit the individual requirements of your institution.

- Simple Operation
  The MedSystem III Pump is very easy to use, and displays directions as prompts to guide the operator in its use. The pump has been designed to make in-service training quick and simple.

- Universal Pole Clamp
  The Pole Clamp provides a sturdy and versatile attachment for the pump, and allows it to be positioned in a variety of viewing or operating angles.

1.2 General Precautions and Inspection

The following general precautions are not related to any specific procedures and, therefore, do not appear elsewhere in this document. These are recommended precautions that personnel must understand and apply during operation and maintenance of the MedSystem III Multi-Channel Infusion Pump.

> ***WARNING:*** *Isopropyl alcohol is flammable and moderately toxic. Avoid contact with eyes. Do not breathe vapors. Eye and skin protection and adequate ventilation are required. Irritation to eyes, skin, lungs, nose and throat may result if personnel fail to observe this warning.*

> ***WARNING:*** *Always make certain power to pump is off when performing maintenance, unless you have been advised to power-up the pump.*

1.2.1 Site of Operation

The operating environment of the pump must meet stringent temperature, humidity, and air pressure requirements.

> ***CAUTION:*** *Do not stack the pumps on top of each other.*

> ***CAUTION:*** *Do not place the pump near any electronic device or other equipment emitting magnetic waves. These waves interfere with the operation of the pump, and may result in an alarm.*

1.2.2 IEC Symbols

⎓	Direct current
∿	Alternating current
⚠	Attention, consult accompanying documents

1.2.3 Inspection and Maintenance

Regular equipment inspection and maintenance is required. Perform the following checks at least every 12 months. Any device that does not meet these inspections should be serviced.

1. Check all cables and connectors for damage.
2. Check equipment and accessories for physical damage.
3. Ensure that all labels are still readable.
4. Test the device as described in the Technical Service Manual for the IVAC MedSystem III Multi-Channel Infusion Pump.
5. Maintain a written record of these inspection checks.

1.2.4 Cautions

- Prior to operating the MedSystem III Pump, all users should thoroughly read the Directions For Use.
- Before placing the MedSystem III Pump into use, charge it for 14 hours to ensure proper operation when using battery power.
- To prevent risk of fire or explosion, only authorized personnel should replace the batteries (both the rechargeable NiCd and the memory backup Lithium). Only the approved IVAC Battery Pack should be used. Failure to use this battery pack can cause damage to the pump.
- Only IVAC 28 and 25 series sets can be used with the MedSystem III Pump's pumping mechanism.

- These sets are supplied sterile for one-time use only. Do not resterilize.

- Purge all air from the fluid pathway of the administration set before connecting it to a patient. Possible air embolism can occur if the fluid pathway is not cleared of all air.

- Only filters that are recommended for use with pumps which have a maximum delivery pressure of 15 psi should be used. Read and follow the instructions on the filter packaging.

- The AC Adapter must be connected to a three-wire, properly grounded receptacle (e.g., one marked hospital use or hospital grade).

- Use the AC Adapter indoors only. It is not designed to withstand contact with fluid or extremely high humidity.

- An electrical shock hazard exists if the MedSystem III Multi-Channel Infusion Pump housing is opened. Refer all servicing to qualified personnel.

- Do not use the MedSystem III Pump in the presence of flammable anesthetics.

- If a display or function ever appears incomplete, or differs from the description given in this manual, stop using the pump immediately. Contact your Biomedical Engineering Department or the Clinical Engineering Department at IVAC Corporation, San Diego, California.

- When infusing two or more medications through the same channel, ensure drug compatibility.

- Backup systems to provide intravenous therapy should always be available in the event of a device malfunction. The MedSystem III Pump is an electronic device with many components. Efforts have been made to ensure the quality and long life of these components; however, any component is subject to possible failure which may cause the pump to malfunction and alarm.

- The MedSystem III Pump is designed to assist the medical professional in intravenous, intra-arterial, subcutaneous, and other fluid and medication delivery. It is not intended to substitute for regular patient observation and evaluation.

- The MedSystem III Pump may alarm when exposed to intense electro-magnetic interferences. Generally, increasing the distance between the pump and the source of interference results in proper operation.

- Operating the pump near equipment which radiates high-energy radio frequencies (e.g., electrosurgical/ cauterizing equipment, portable radio, cellular telephones) may cause false alarm conditions. If this happens, reposition pump away from the source of interference; or, turn off the pump, close clamp, remove tubing from pump mechanism, and manually regulate flow with set regulating clamp.

- If the pump is dropped or severely jarred, it should be inspected by a qualified service technician to ensure it is functioning properly.

- It is normal for intravenous infusion devices to produce nonhazardous currents when infusing electrolytes. These currents vary at a rate proportional to the infusion device flow rate. When the ECG system is not functioning under optimal conditions, these currents may appear as artifacts, simulating actual ECG readings. To determine if ECG abnormalities are caused by patient condition or the ECG equipment, place the infusion device on hold. If the ECG readings become normal, the ECG equipment requires attention. Proper setup and maintenance of the ECG equipment should eliminate these artifacts. Reference the appropriate ECG monitoring system documentation for instructions on setup and maintenance.

- When infusing fluid, ensure the cassette is in an upright position. The air trap will not trap air when the cassette is inverted more than 90° from vertical, which may result in nuisance air-in-line alarms.

- When patients are at high risk for air embolism, follow ECRI (ECRI, Plymouth Meeting, PA) guidelines concerning the use of air-eliminating filters.

- Do not use the administration set if the pressure dome on the cassette is cut or torn.

- IVAC 28 and 25 series administration sets are available in both 20 and 60 drop/ml, with the standard vent closure configuration (vented/unvented). Ensure that the set you have is appropriate for its intended application.

- Always ensure proper placement of the cassette slide clamp. When the cassette is installed, slide clamp is flush with the entire cassette. The clamp should be pulled all the way out when you are pushing the cassette in or pulling it out of a cassette holder. A fully extended cassette slide clamp occludes the tubing and minimizes unrestricted flow of fluid.

- Unrestricted flow will occur if the cassette is removed from the pump and the slide clamp is pushed all the way in prior to closing the regulating clamp.

- If the vent on a burette is closed or clamped off, the pump will continue to pump accurately, but under certain conditions may collapse the burette significantly prior to alarming for Fluid-side Occlusion. In such situations, it is important to open the burette vent prior to removing the cassette from the pump and opening the cassette's slide clamp.

- If a pump requires service, do not insert a cassette into the faulty channel. Other channels may be used normally. If a cassette is in place in a channel marked Service, remove it.

- Before cleaning the pump, unplug the AC Adapter from both the AC wall outlet and the pump (unless the adapter is locked onto the pump). Refer to Section 10.0 on Cleaning.

- Do not use organic solvents, ammonia, ammonium-based agents, or abrasive cleaners on the MedSystem III Multi-Channel Infusion Pump. Prolonged or repeated exposure to alcohol can damage plastic parts. Avoid contacting the LCD windows with alcohol. DO NOT steam sterilize, ETO sterilize or autoclave the pump.

- Do not use alcohol to clean the cassette sensors (optomodule).

- Never apply alcohol to a cassette intended for patient use.

- To avoid mechanical or electronic damage, do not immerse the pump in any fluids or cleaning solutions.

- When using the pump in the Dual Rate (IVPB) Mode with a secondary container, the secondary rate should not exceed 275 ml/h, and the secondary set should have a 16-gauge needle.

- Do not twist the connectors when inserting or removing the AC Adapter or the communications cable. Excess force by twisting may cause damage to the connector, the socket, or both.

1.2.5 Special Notes

Occlusion Detection

The baseline method of downstream occlusion detection involves the channel measuring the pressure when the infusion starts, and setting the occlusion alarm level at an increment above this baseline pressure. For example, a General Purpose Device Type set at baseline +5 psi will alarm when line pressure exceeds the baseline pressure by 5 psi.

Absolute threshold occlusion detection means that the occlusion pressure alarm is fixed at a certain value, and the channel will alarm whenever that level of back pressure is reached. For example, the Controller Pressure Device Type will alarm at a pressure equivalent to 3 feet of water, regardless of the initial pressure required to overcome backpressure in the IV line.

The maximum pressure of the MedSystem III Multi-Channel Infusion Pump is 15 psi, regardless of baseline pressure.

Air-in-line Detection

The Air-in-Line detection system is designed to address two different conditions:

1. Transient bubble detection, where the sensor detects a set amount of air (the threshold setting in Table 4-1, typically 50 - 500 µl) in a set volume of fluid (typically 1 to 3 ml).
2. Repeated bubble detection, where an internal counter alerts the operator to a chronic source of small bubbles that are passing the sensor.

These methods provide improved detection of air-in-line conditions over other systems, and at the same time minimize nuisance alarms. It is not strictly comparable to air-in-line tests for a single set point, e.g., a single 50- or 100-µl bubble. For example, with the MedSystem III Pump in Neonatal Device Type and a 50-µl air-in-line threshold, two 25-µl bubbles next to each other (in 1 ml of fluid) will trigger an alarm, whereas with other devices that look only at the size of a single bubble, two 25-µl bubbles will not trigger an alarm. Also, in other instruments a chronic source of bubbles, each of which is below the air-in-line threshold, will not be detected. However, the "repeated bubble detection" of the MedSystem III Pump identifies such a condition and alerts the user.

The Air-in-Line factory settings in Table 4-1 (50 µl in Neonatal, 500 µl in all other Device Types) were arrived at through clinical experience, but can be set to other values per your institution's needs.

2.0 Components

This section identifies and describes the various components of the MedSystem III Multi-Channel Infusion Pump. It provides explanations of the softkeys and other controls that are basic to understanding the setup procedures and use of the pump.

2.1 Front Panel

The keys on the front panel of the MedSystem III Pump (Figure 2-1) are used to control the whole pump, as well as individual channels. Instrument control keys affect the functions of all three channels (the whole pump). The channel control keys affect only the functions of the selected channel (A, B, or C). Softkey functions change during operation of the pump, and can affect the whole pump or an individual channel.

2.1.1 Instrument Control Keys

- **ON/OFF RECHARGE**
  This key allows the operator to turn the pump on and off. When the pump is off, but still connected to AC power, the main batteries will continue to be recharged.

- **STANDARD DISPLAY**
  This key allows the operator to return to the Standard Display Page from any point during programming. Refer to Section 4.3.

- **MORE OPTIONS**
  This key is used to display additional instrument and channel specific softkey options.

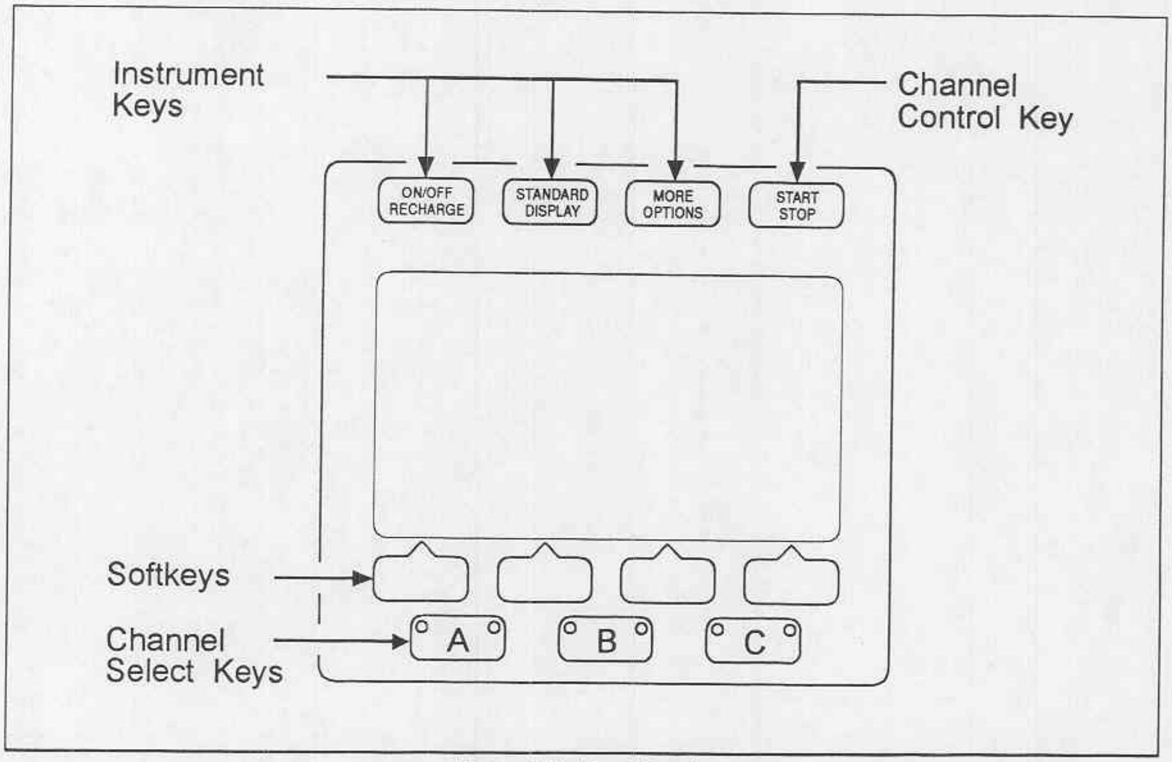


Figure 2-1: Front Panel

2.1.2 Channel Control Keys

- **CHANNEL SELECT**
  These keys are marked **A**, **B**, and **C**, and allow the operator to choose the desired channel to program, start, and stop an infusion. Pressing A, for example:

(1) changes the display to the Channel Page for channel A,

(2) allows the operator to program channel A (programming channels is discussed in Section 4.5), and

(3) highlights the status line for channel A to indicate that channel A is now the selected channel.

The Channel Select Keys each contain two LED lights. These small lights appear in the upper corners of the three Channel Select Keys and convey information specific to a channel condition:

- The green LED light is continuous when an infusion is taking place while the pump is running on AC power.
- The green LED light will blink when an infusion is taking place while the pump is running on its batteries.
- The red LED light will blink when an advisory or alarm condition exists on that specific channel.

- **START/STOP**
  This key is used to start or temporarily stop infusion regimens, and only affects the currently selected channel.

2.1.3 Softkeys

The four keys directly beneath the LCD screen are called "softkeys." Softkeys are not labeled because their functions change during programming. The specific function for a given softkey appears just above it on the LCD screen, and may be different for different programming situations. Note that softkey functions on the Standard Display Page affect the whole instrument.

Pressing the **MORE OPTIONS** key displays the next set of softkey options. If only one set of softkey options is available, pressing the **MORE OPTIONS** key does nothing, and the prompt line will indicate that no more options are available. After all sets of softkey options have been displayed, pressing **MORE OPTIONS** again returns the display to the first set of softkey options.

2.2 LCD Screen

The LCD screen displays various information about the pump and the individual channels. When the pump is running on battery power, the LCD will be backlit for 1 minute (default) after any key is pressed. When operating on AC power, backlighting is on continuously, or for a programmed length of time.

2.3 Connector Panel

The connector panel is shown in Figure 2-2.

2.3.1 External Power Receptacle

This is the receptacle where the AC adapter plugs into the MedSystem III Pump (Figure 2-2). The small electrical plug symbol next to the power receptacle will light up in green when the pump is connected to AC power.

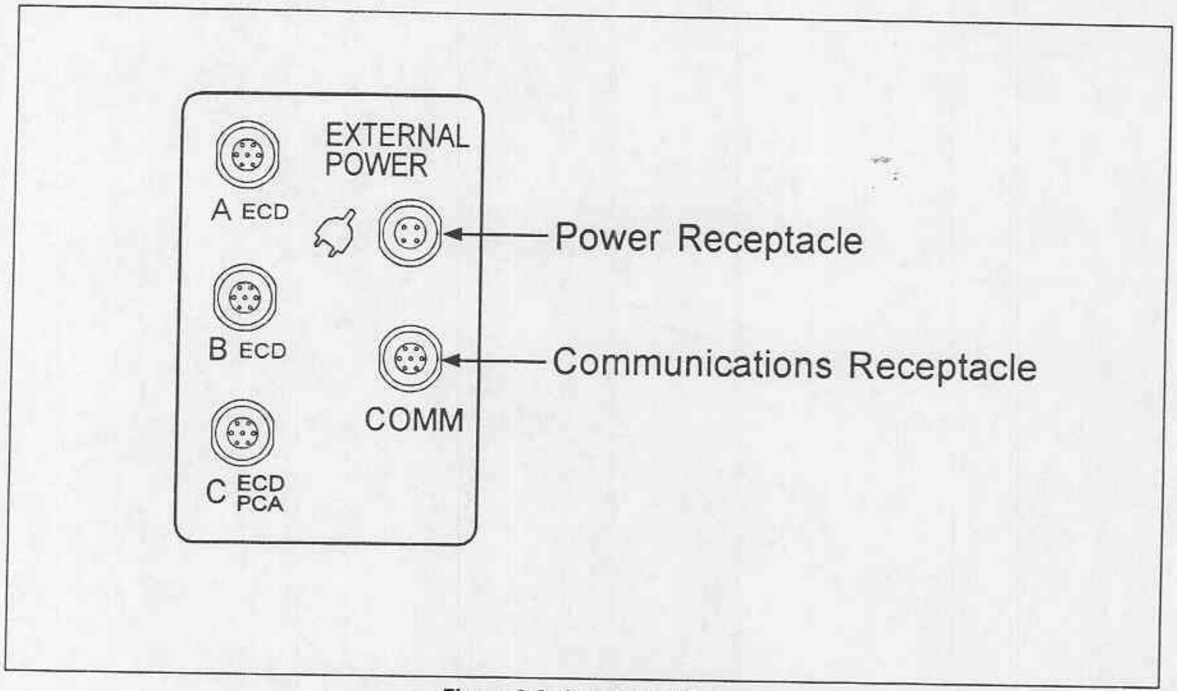


Figure 2-2: Connector Panel

2.3.2 Communications Receptacle

The communications receptacle is an RS-232 serial connector labeled **COMM** (Figure 2-2). It allows the pump to communicate with other microprocessor based devices. Its operation and function will be described with future software enhancements.

2.4 Cassette Latch

The three cassette latches are on the underside of the pump (protected by the lower housing) and hold the cassettes when they are inserted into the channel.

2.5 Lower Housing

The lower housing is a removable plastic part which covers the underside of the cassettes when they are in the pump. It contains two fluid container hooks for holding bags or bottles.

2.6 AC Adapter

The AC adapter for the MedSystem III Pump is an 8-1/2-foot long, 110V, 60 Hz power cord with a three-pronged grounded adapter. This adapter allows recharging of the main batteries, while at the same time powering the pump.

3.0 Initial Installation

This section describes how to properly set up the MedSystem III Multi-Channel Infusion Pump, including attachment and operation of the AC power cord and pole clamp.

3.1 Unpacking

Unpack the pump from the shipping box. Verify that the pump has a pole clamp attached and that an AC adapter is included.

3.2 Charging the Battery

Before placing the MedSystem III Pump into initial use, charge it for 14 hours. This will ensure proper operation when using battery power.

3.3 Universal Pole Clamp

The Universal Pole Clamp (Figure 3-1) is a versatile accessary which can be used to mount the MedSystem III Pump on a variety of surfaces. It can be attached to an IV pole, a table top, a bed, a wheel-chair, or it can be used as a stabilizer stand when placing the pump on a shelf. The pole clamp also allows the pump to be rotated in several directions, thus enabling the user to adjust it to an optimal viewing angle.

To attach the pole clamp to a mounting surface, e.g., an IV pole, position the clamp jaw over the pole and turn the knob until the clamp is tightened and the pump feels secure on the pole. Note that when the knob is at its maximum tightness, continued turning will cause it to click and spin freely. This feature is designed to prevent the clamp from being over-tightened.

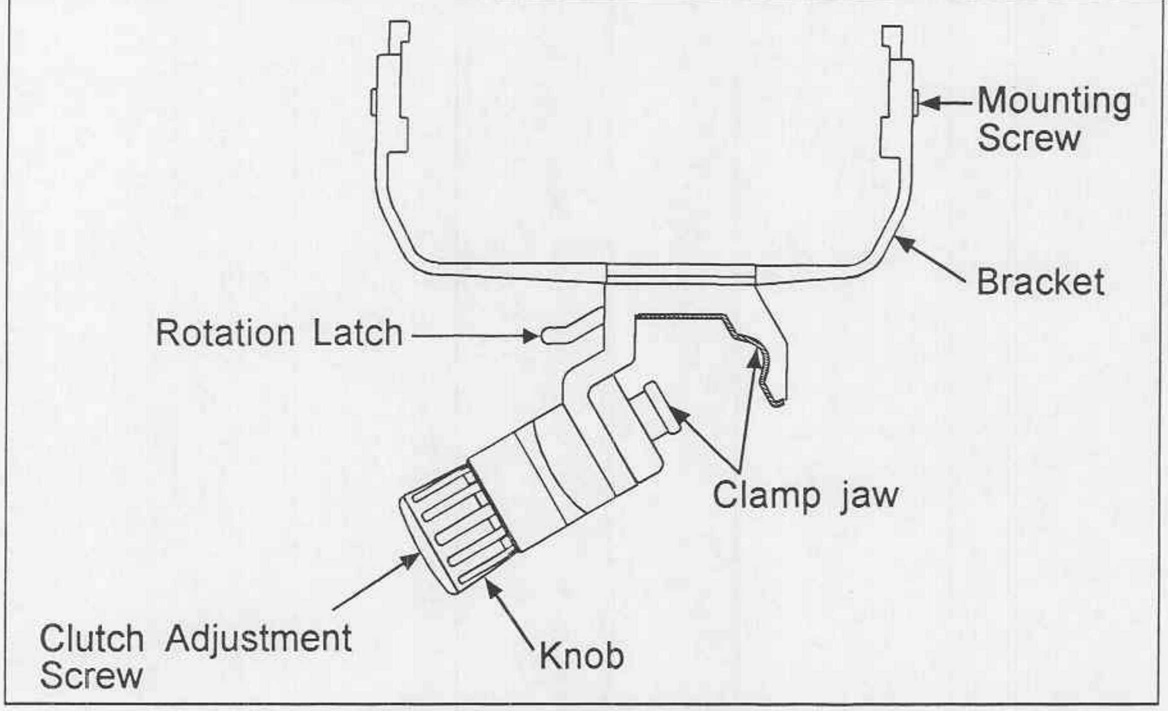


Figure 3-1: Universal Pole Clamp (Back View)

3.3.1 Operating the Pole Clamp

To orient the pump in the desired upright position, press the Rotation Latch (Figure 3-1). The pump can then be rotated in increments of 90° in either direction. After rotation is complete, release the Rotation Latch to lock the pump into position.

The clamp also allows the pump to be rotated from front to back. With the pole clamp properly attached to the pump and mounted on a surface, simply grasp the pump on both sides and rotate it toward or away from you to optimize the viewing angle.

3.3.2 AC Adapter Attachment

The AC adapter allows the pump to operate on AC power. It also permits the main batteries to be recharged while the pump is on or off.

Plug the AC adapter into the external power receptacle located on the side of the MedSystem III Multi-Channel Infusion Pump. When inserted properly you will feel the AC adapter snap into place. If the pump is ON, and the power cord is plugged into an AC outlet, you will hear three short beeps as the AC adapter is inserted.

Plug the AC adapter into a standard 110V grounded wall socket. When the pump is on AC power, the small electrical plug symbol on the receptacle panel will be lit in green. Also, when the pump is running on AC power, a continuous green LED light will appear on the **A**, **B**, or **C** key, if the given channel is infusing. When the pump is operating on battery power, the green LED light will blink.

4.0 Programming the MedSystem III Multi-Channel Infusion Pump

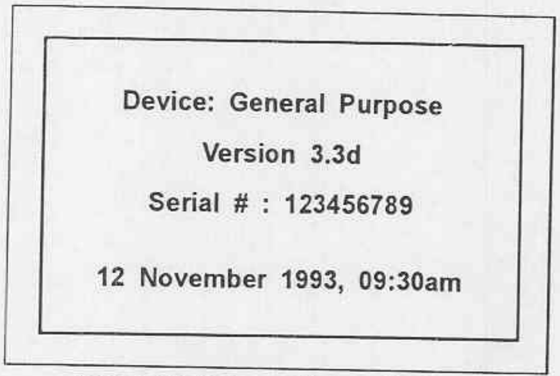
This section describes the programming procedures necessary for setting up infusions and the various screens that appear during operation.

4.1 Turning On the Pump

To turn on the pump, press and release the **ON/OFF RECHARGE** key located on the front panel.

4.2 Instrument Information Page

Immediately after turning on the pump, an Instrument Information Page (Figure 4-1) will appear for 3 seconds, or for as long as you hold the **ON/OFF** key in. Verify that the Device Type is set properly for the application you intend to use. Also verify that the Date and Time are correct, and that the program version number corresponds with the one listed on the cover of this manual. Information on this page can also be accessed from the Standard Display Page by pressing the **MORE OPTIONS** key, then the **I.D.** softkey.



Device: General Purpose

Version 3.3d

Serial # : 123456789

12 November 1993, 09:30am

Figure 4-1: Instrument Information Page

4.2.1 Device Type

The MedSystem III Multi-Channel Infusion Pump can operate as one of several different Device Types:

- General Purpose
- Neonatal
- Operating Room
- Controller Pressure
- General Purpose II
- Operating Room II

The default settings in each of these modes are different, with safeguards and functions specific to that type of operation. Once a Device Type is set, all three channels (A, B, and C) operate in that configuration. Therefore, channels cannot operate with different Device Type settings. Table 4-1 shows factory default settings for the Device Types.

4.2.2 Program Version

The program version refers to the software that is contained within the pump. Because future upgrades will expand the capabilities of the infusion pump, it is important for you to know which version of software is contained in the pump you are using.

4.2.3 Serial Number and User Information Line

These two lines give information concerning pump identification: The pump serial number and the optional User Information Line. The User Information Line can be entered by your institution, including institution or unit name, identification number, etc., up to 25 characters in length. It is entered via Field Maintenance Software (FMS). Refer to Section 11.0.

TABLE 4-1
COMPARISON OF FACTORY DEFAULT SETTINGS FOR DEVICE TYPES

	Device Type					
Default Parameter	**General Purpose**	**Neonatal**	**Controller Pressure**	**Operating Room**	**General Purpose II**	**Operating Room II**
Occlusion Detection Method*	Baseline	Baseline	Absolute Threshold	Baseline	Baseline	Baseline
Occlusion Alarm Setting	Baseline +5 psi	Baseline +3 psi	Absolute 3 ft H_2O	Baseline +5 psi	Baseline +5 psi	Baseline +5 psi
Maximum Pressure	15 psi	15 psi	3 ft H_2O	15 psi	15 psi	15 psi
Air-in-line Alarm Threshold, μl	500	50	500	500	500	500
KVO Rate**, ml/h	3.0	1.0	3.0	3.0	3.0	3.0
Rate Range, ml/h	1 - 999	0.1 - 99.9	1 - 299	1 - 999	0.1 - 999	0.1 - 999
Maximum VR Setting, ml/h	9999	999.9	9999	9999	9999	9999
Pump Not In Use Advisory*	Yes	Yes	Yes	No	Yes	No
ALL Setting for Volume Remaining	N/A	N/A	N/A	(Optional)	N/A	(Optional)

*Settings which cannot be changed.
**KVO setting equals table value or the current rate, whichever is lower.

4.2.4 Date and Time Settings

The bottom of the display shows the current Date and Time set in the pump. To change Date and Time settings, refer to Section 4.18.

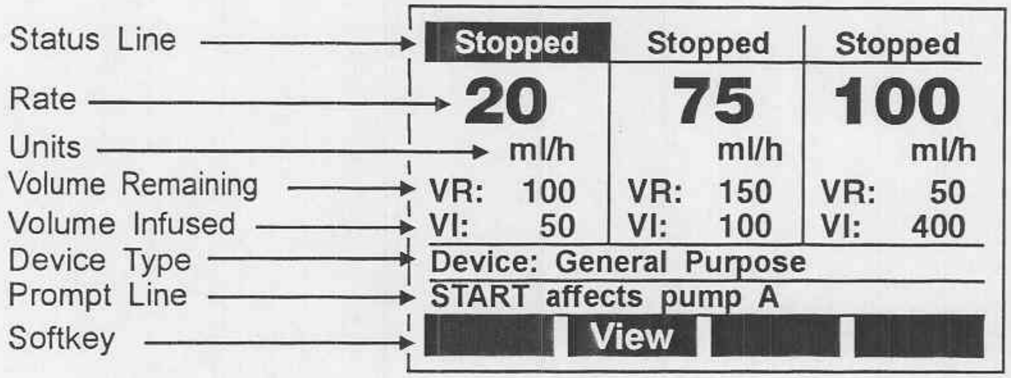
NOTE: It is important to verify the Clinical Device Type, Program Version, and the Date and Time settings. If you need more than 3 seconds to do this, hold the **ON/OFF** key in when first turning on the pump, and the display will remain until you release the key.

4.2.5 Special Note Page

After you release the **ON/OFF** key, the screen will go to the Standard Display Page. However, if a Special Note Page has been set up, it will appear with up to five lines of text. After reading the note, you can clear it by pressing the **Clear** softkey. The Special Note is entered into the pump with FMS, and may be set to appear at a future date. Refer to Section 11.0.

4.3 Standard Display Page

After the Instrument Information Page clears, the Standard Display Page (Figure 4-2) will appear. The Standard Display Page allows you to see infusion information for all active channels. This display will remain on the screen until you do specific programming operations. Pressing the **STANDARD DISPLAY** key will always return you to the Standard Display Page, except during actual entry of programming values.



Stopped	Stopped	Stopped
20	75	100
ml/h	ml/h	ml/h
VR: 100	VR: 150	VR: 50
VI: 50	VI: 100	VI: 400

Device: General Purpose
START affects pump A

Figure 4-2: Standard Display Page

NOTE: If a channel is not being used (i.e., it is not the selected channel with a highlighted status line, or it does not have a cassette in place) its information will disappear from the Standard Display Page after 2 minutes.

4.3.1 Status Line

The top line on the Standard Display Page is called the channel status line. It provides information about the status for each of the three channels. Status messages include *INFUSING, STOPPED, STANDBY, KVO* (Keep Vein Open), *ALARM*, *FAULT*, and *SERVICE*. The channel currently selected is indicated by a highlighted status line (e.g., channel A in Figure 4-2).

4.3.2 Rate

The Rate line displays the rate that has been programmed for the given channel. The value for the rate is the topmost number on the display (Figure 4-2).

4.3.3 Units of "ml/h"

This line shows that the programmed rates are in units of ml/h.

4.3.4 Volume Remaining

This line displays the *Volume Remaining (VR)*, which is the volume of fluid that was programmed to be delivered for the given channel. It is equivalent to the volume-to-be-infused setting on certain other infusion pumps.

4.3.5 Volume Infused

This line displays the *Volume Infused (VI)*, which is the volume of fluid that has been infused by the given channel since VI was last cleared to zero.

4.3.6 Device Type

This line indicates which Device Type is presently chosen: *General Purpose, Neonatal, Controller Pressure, Operating Room, General Purpose II* or *Operating Room II*. If Dual Rate has been enabled, this line will alternate between *Device Type* and *1 °Pri* or *2 °Sec*, which indicates whether a particular channel is in Primary or Secondary Mode. Figure 4-3 shows *General Purpose* as the selected Device Type. The Device Type affects the default settings of the pump. Table 4-1 lists the settings unique to each Device Type.

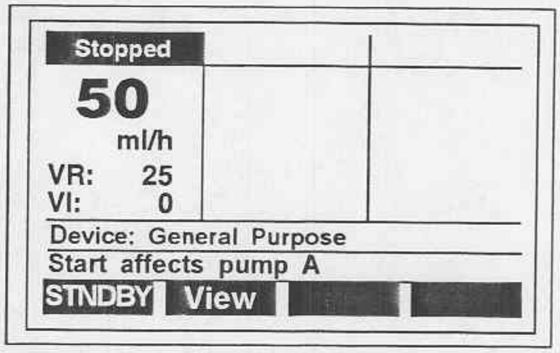

Stopped
50
ml/h
VR: 25
VI: 0
Device: General Purpose
Start affects pump A

Figure 4-3: Standard Display with Channel A in Use and General Purpose as the Selected Device Type

4.3.7 Prompt Line

The message on this line will prompt the user to make programming choices or take appropriate corrective actions regarding the infusion. There may be several alternating messages on the prompt line.

4.3.8 Softkey Functions

The labels on each of the softkey options on the screen change, depending upon where you are in the programming sequence. These options correspond to the unlabeled softkeys located directly beneath them on the front panel. An active softkey on the Standard Display Page is **View**, and another, when applicable, is **STNDBY** (Standby).

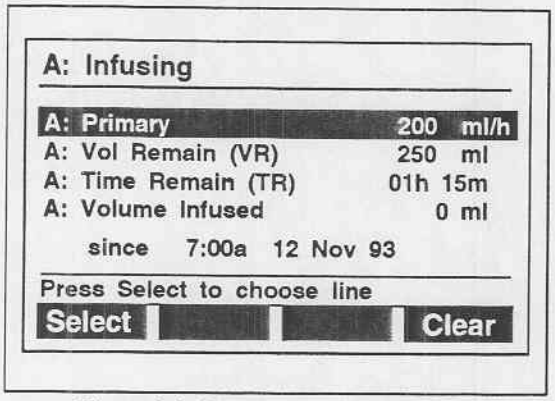
4.4 Adjusting the Viewing Contrast

The **View** softkey on the Standard Display Page changes the contrast so that the screen is easier to read from different viewing angles.

1. To return to the Standard Display Page, if you are on another page, press **STANDARD DISPLAY**. A softkey labeled **View** appears.
2. Press and hold the **View** softkey to ramp up and down the seven different contrast levels. (Pressing and releasing **View** changes the contrast one increment at a time).
3. Release the **View** softkey when the display appears most clear.

4.5 Channel Page

The Channel Page appears on the screen when you press the **A**, **B**, or **C** key. This screen provides access to the programming capabilities of the MedSystem III Pump. It displays information pertaining to the specific channel that you have chosen, and allows you to review settings or make any necessary changes. Figure 4-4 shows Channel A as the selected channel (*A: Infusing*). Press **Select** to highlight the desired setting (Rate is highlighted in Figure 4-4); then press the ▲ or ▼ softkey to change the value.



```
A: Infusing

A: Primary                 200  ml/h
A: Vol Remain (VR)         250  ml
A: Time Remain (TR)       01h 15m
A: Volume Infused            0  ml
    since   7:00a   12 Nov 93
Press Select to choose line
```

Figure 4-4: Channel Page for Channel A

4.6 General Procedure for Setting or Changing Infusion Settings

The general procedure for changing infusion settings on the pump has been designed to be both simple and consistent.

1. Press the **A**, **B**, or **C** key to select the desired channel and to display that specific Channel Page.
2. Press the softkey that corresponds to the word **Select** on the display to move the highlighted bar to the line you wish to change.
3. After selecting or highlighting the desired line, press the ▲ or ▼ softkey to change the value or press the **Clear** softkey to clear the value.
4. Press the **Accept** softkey to confirm the new value, or press **Recall** to recall the old value.

NOTE: (1) If you change a value but do not press either the **Accept** or **Recall** key within 15 seconds, the pump will alarm to remind you that the value has not been accepted or recalled. You must always press either **Accept** or **Recall**. (2) If you do not push any keys for 1 minute while on the Channel Page, the screen will automatically return to the Standard Display Page. (3) If the channel is infusing at the time a change is made, that change takes place immediately upon pressing the **Accept** softkey.

4.7 Setting a Rate and Volume Remaining Infusion

A Rate and VR infusion is initiated by setting both a value for Rate and a value for VR, other than *ALL*. When Rate and VR are entered, the Time Remaining (TR) for the infusion is automatically calculated and displayed. The VR counts down as it infuses, and the channel will alarm and switch to a KVO rate when the infusion is complete (VR=0).

1. Press the key labeled **A**, **B**, or **C** depending on which channel you wish to set. The Standard Display will be replaced by the individual Channel Page. Refer to Figure 4-4.
2. Read the alternating messages on the prompt line.
3. To change the Rate, press the **Select** softkey until the Rate line is highlighted as shown in Figure 4-4.
4. Press the **▲ or ▼** softkey to set Rate to the appropriate value. Each press increments the Rate 0.1 or 1.0 milliliter at a time, depending on the selected Device Type. Press and hold the **▲ or ▼** softkey to rapidly scroll the values for Rate. Note that scrolling will pause briefly at common rate settings.

   NOTE: The action of scrolling backward from low to high rates is deliberate. A complete stop is incorporated at 0.1 or 1 ml/h when scrolling backward from 0.1 or 1 ml/h to 99.9 or 999 ml/h, or vice versa. To continue scrolling, the arrow key must be released and pressed again. When either transition occurs, a two-toned beep is emitted.

5. Press Accept to confirm the new value, or press **Recall** to return to the old value for Rate.

NOTE: Time Remaining (TR) is automatically recalculated each time you accept a new value for Rate.

6. Select the VR line.
7. Press the **▲ or ▼** softkey to set VR to the desired value. Note scrolling will pause briefly at common VR settings. Also, if VR=0, then a **REPEAT** softkey is available. Pressing **REPEAT** will bring up the previous VR setting.
8. Press **Accept** to confirm the new value, or press **Recall** to return to the old value for VR.

NOTE: TR is automatically recalculated each time you accept a new value for VR.

9. Press the **START/STOP** key to begin the infusion. Note that a green light appears on the corresponding channel control key. The green light blinks when the pump is operating on batteries, but is constant when it is connected to AC power. Verify flow.

   NOTE: If the channel is infusing when a change is made, the change takes place immediately when the **Accept** softkey is pressed.

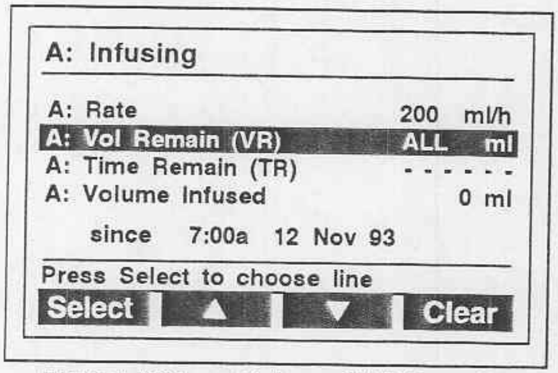
10. Press the **STANDARD DISPLAY** key to return to Standard Display page. Verify settings.

4.8 Setting a Rate Only Infusion

A Rate Only infusion is used for titrating drug levels or for long-term flow rates where you do not wish to enter a volume. The VR should be set to *ALL*. This is an option that can be enabled only in the Operating Room Device Types by using FMS. Refer to Section 11.0.

A Rate Only infusion is initiated by setting a value for Rate, and setting the VR to *ALL*. With the VR set to *ALL*, the channel will continue to infuse at the set rate until an air-in-line alarm occurs or, in the case of syringes, a fluid-side occlusion alarm occurs.

1. Press the key labeled **A**, **B**, or **C**, depending on which channel you wish to set. The Standard Display Page will be replaced by the individual Channel Page (Figure 4-5).



A: Infusing

A: Rate	200 ml/h
A: Vol Remain (VR)	ALL ml
A: Time Remain (TR)	- - - - - -
A: Volume Infused	0 ml
since 7:00a 12 Nov 93	

Press Select to choose line

Figure 4-5: Channel A Page with VR Set to *ALL*

2. Read the alternating messages on the prompt line.
3. Verify that VR equals *ALL*. If not, press the **Select** softkey until VR is highlighted, then press either **Clear** or the arrow softkeys until *ALL* appears (*ALL* appears between the highest and the lowest setting for VR, if it is enabled on your instrument). Press **Accept** to confirm the *ALL* setting.
4. To change Rate, press the **Select** softkey until the Rate line is highlighted.
5. Press the arrow softkeys to set Rate to the appropriate value. Each press will increase Rate 0.1 or 1.0 milliliter at a time, depending on the selected Device Type. Press and hold the arrow softkey will rapidly scroll values for Rate.
6. Press **Accept** to confirm the new value, or press **Recall** to return to the old value for Rate.
7. Press the **START/STOP** key to begin the infusion. Note that a green light appears on the corresponding channel control key. The green light blinks when the pump is operating on batteries, but is constant when the MedSystem III Pump is connected to AC power.
8. Return to the Standard Display by pressing the **STANDARD DISPLAY** key. The Channel Page will automatically return to the Standard Display Page 1 minute after the last key press.

NOTE: If the channel is infusing when a change is made, the change takes place immediately after the **Accept** softkey has been pressed.

4.9 Setting a Volume Remaining and Time Remaining Infusion

An alternative to a Rate and VR infusion is a VR and TR infusion. A VR and TR infusion is initiated by setting a value for both VR and TR. The instrument automatically calculates the appropriate Rate. The Setup line option must be enabled to set a VR and TR infusion [refer to section 4.15, paragraph 4 (3), Setup Line Option].

1. Press the key labeled **A**, **B**, or **C**, depending on which channel you wish to set. The Standard Display Page will be replaced by the individual Channel Page.
2. Read the alternating messages on the prompt line.
3. Press the **START/STOP** softkey to stop the pump, if infusing.
4. The Setup Line should read *Setup: Select VR and Time*. If it does not, use **Select** to highlight the Setup Line, then press either **▲ or ▼** to change the setup to *Setup: Select VR and Time*. Then press the **Accept** softkey to confirm the change. Any previous rate, volume, or time values will be cleared.
5. To change the VR, press **Select** until the VR line is highlighted.
6. Press the **▲ or ▼** softkey to set the VR to the desired value.

7. Press **Accept** to confirm the new value, or press **Recall** to return to the old value for VR.

   NOTE: Rate is automatically recalculated each time you accept a new value for VR.

8. Press **Select** to move the highlighted bar to the TR line.

9. Press the arrow softkeys to set TR to the desired value.

10. Press **Accept** to confirm the new value or press **Recall** to return to the old value for TR.

    NOTE: Rate is automatically recalculated each time you accept a new value for TR.

11. Press **START/STOP** to begin the infusion. Note that a green light appears on the corresponding channel control key. The green light blinks when the instrument is operating on batteries, but is constant when it is connected to AC power.

    NOTE: If the channel is infusing when a change is made, the change takes place as soon as the **Accept** softkey is pressed. However, if the new calculated Rate is not within the range of the Device Type being used, the change will not be accepted, and the old Rate value will remain. The following prompt will be displayed: *RATE TOO HIGH/LOW, RE-ENTER VR/TR*. The channel must be stopped to continue.

    NOTE: If the channel is not infusing when a change is made and the new calculated Rate is out of range, it will be displayed as (----). VR or TR must be changed to bring the Rate into an acceptable range before the infusion can be started.

4.10 Clearing the Volume Infused (VI) on a Single Channel

1. Press **A**, **B**, or **C**, depending on the channel Volume Infused value you wish to clear. The Standard Display will be replaced by the individual Channel Page.

2. Press **Select** until the Volume Infused line is highlighted.

3. Press **Clear** to change the Volume Infused to zero.

4. Press **Accept** to confirm or **Recall** to return to the previous Volume Infused value.

5. If the channel is not infusing when Volume Infused is cleared, the time and date will be displayed as (----) until the channel is started. If the channel is infusing when Volume Infused is cleared, the time and date will be reset to the current time and date.

4.11 Placing a Channel on Standby

There may be circumstances when you wish to set up an infusion before you are actually ready to start it. Using the Standby function allows such a set-up without causing a *Pump Not In Use* advisory.

NOTE: There are two conditions under which a *Pump Not In Use* (or callback) advisory will occur to prevent a channel from accidentally being left *Stopped*. These are: (1) a cassette is installed and the channel is not started (the alarm will occur after 2 minutes); and, (2) an infusion is stopped and the cassette is left in place (the alarm will occur after 2 minutes).

A channel on *Standby* will not alarm. A channel can only be placed on *Standby* if a cassette is in place and the channel is not infusing.

> **NOTE:** No **STNDBY** softkey is available in the Operating Room Device Type, as the *Pump Not in Use* advisory alarm is not used in this Device Type. When stopped, the channel is automatically placed in *Standby*.

1. The **STNDBY** softkey on the Standard Display Page affects all channels that are stopped and have a cassette in place. Pressing the **STNDBY** softkey changes the status line of those channels from *Stopped* to *Standby*.
2. To start a channel on Standby, first press the **A**, **B**, or **C** key to select the desired channel, then press the **START/STOP** key.

4.12 Clearing An Unused Channel

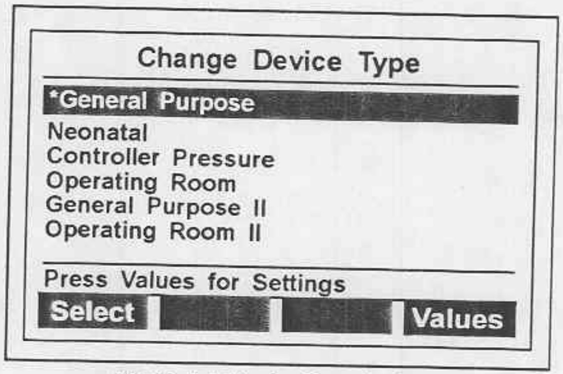
To clear information for channels not in use, press the channel key for the channel you wish to clear. If the channel is not stopped, press **STOP/START** to stop it, and then remove the cassette. Next, press the channel key for any infusing channel. After 2 minutes information on the unused channel will disappear.

4.13 Using the I.D. Softkey

Available on the Standard Display Page after pressing the **MORE OPTIONS** key once, this softkey allows the operator to review information from the Instrument Information Page described in Section 4.2. Press **STANDARD DISPLAY** to exit.

4.14 Using the Device Softkey

Available on the Standard Display Page after pressing the **MORE OPTIONS** key once, the **Device** softkey allows the operator to change or review the current Device Type (Figure 4-6). The Device Type affects all three channels. It is not possible to set different Device Types for different channels. All three channels will always be in the same Device Type.



Change Device Type

*General Purpose
Neonatal
Controller Pressure
Operating Room
General Purpose II
Operating Room II

Press Values for Settings

Figure 4-6: Device Type Settings

The factory default settings for the different Device Types are shown in Table 4-1. Device Types can be changed while an infusion is in progress without stopping lines or resetting any compatible values.

However, if the Rate or Volume settings in the current Device Type are not compatible with the new Device Type, the affected channels will be stopped, the incompatible values cleared, and an alarm generated.

4.14.1 Changing Device Types

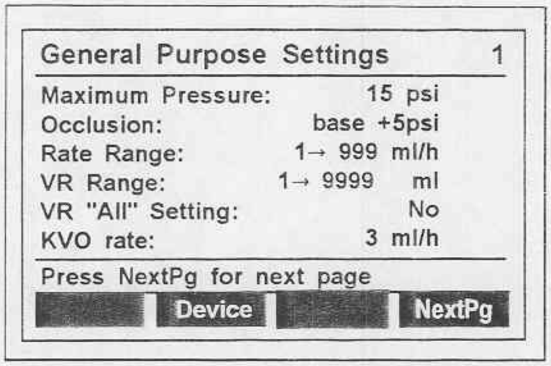
> NOTE: Depending upon your institution's policy, changing the Device Type may or may not be possible. If the Device Type is locked out, you can review the Device Type, but you cannot change it.

1. On the Standard Display Page, press the **MORE OPTIONS** key once.

2. Press the Device softkey. The Change Device Type Page will appear with the current Device Type marked by an asterisk.
3. Use the Select softkey to select the desired Device Type.
4. Press the Accept softkey to confirm the new Device Type.
5. When a channel is infusing, if current settings for rates or volumes are incompatible with the new Device Type, a Caution Page will appear. You can either return to the current Device Type and reset any incompatible values, or you can continue with the Device Type change. If you choose to continue, affected channels and modes will be stopped, incompatible values cleared, and a Rate/Vol Settings Cleared alarm will be generated.

4.14.2 Reviewing Device Type Settings

To review the current Device Type settings (Figure 4-7), press the **Values** softkey while on the Change Device Type **Page**. To access the Change Device Type Page, refer to Section 4.14.1. Press the **NextPg** softkey to see additional pages of settings for the current Device Type, or press the **Device** softkey to return to the Change Device Type Page.



Maximum Pressure: 15 psi
Occlusion: base +5psi
Rate Range: 1→ 999 ml/h
VR Range: 1→ 9999 ml
VR "All" Setting: No
KVO rate: 3 ml/h

Press NextPg for next page

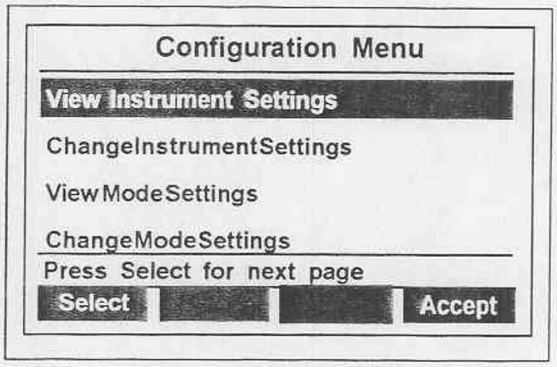
Figure 4-7: Current Device Type Default Settings

NOTE: Any settings that are different from factory default settings will be marked with an asterisk.

4.15 Using the Config Softkey

The **Config** softkey is available on the Standard Display Page after pressing the **MORE OPTIONS** key once. It lets the user either view or change instrument and mode settings.

1. From the Standard Display Page, press the **MORE OPTIONS** key.
2. Press the **Config** softkey.
3. Select either *View Instrument Settings* or *Change Instrument Settings* or select *View Mode Settings* or *Change Mode Settings* from the Configuration Menu (Figure 4-8).



Press Select for next page

Figure 4-8: Configuration Menu Page

(1) The user may view all current instrument or mode settings. Any settings that are different from factory settings will be marked with an asterisk.

(2) Only parameters that the user can change are visible on the Change Instrument Settings or Change Mode Settings pages.

4. To change mode settings, refer to Section 8.0, Additional Operating Modes.

The following Instrument Settings can be changed:

(1) Audio Volume

This allows the setting of the initial alarm tone volume. Note that regardless of the initial setting, alarm volume will automatically increase to the highest setting if any alarm is ignored.

(2) Backlight Timeout

When the pump is operating on AC power, this function allows the user to set the amount of time the backlight remains on after the last button press. Timeout can be set to 1, 2, 3, 4 or 5 minutes, or to *None* for continuous backlighting. When the pump is operating on batteries, the backlight timeout is always 1 minute.

(3) Setup Line Option

This allows enabling of the Setup Line on the individual channel pages. When enabled, the Setup Line allows the operator to change the way individual infusions are specified, either by setting the VR and Rate, or by setting the VR and Time. Refer to Section 4.9.

4.16 Using the Note Softkey

The **Note** softkey is available on the Standard Display Page after pressing the **MORE OPTIONS** key once. A Special Note of up to five lines can be entered into the pump, using FMS. Refer to Section 11.0. Normally, when the pump is turned on, the Standard Display Page appears. However, when a special note has been entered and the pump is turned on, the Special Note Page will be displayed first. By pressing the **Note** softkey, the user can access the Special Note Page at any time. To exit, press **STANDARD DISPLAY**.

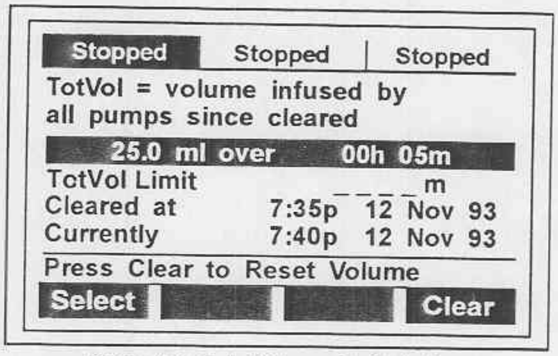
If the **Note** softkey is pressed and no special note has been entered, the message *There is no Special Note* will appear, accompanied by an audible tone. The message will disappear automatically.

4.17 Using the TotVol Softkey

The total volume (**TotVol**) softkey is used to either review or clear the total volume infused on all three channels combined since total volume was last cleared. Note that the total volume does not necessarily equal the sum of the Volume Infused values of channels A, B, and C, because the individual channels may have been reset to zero several times since the total volume was last cleared.

Another feature available from the TotVol page is TotVol Limit. This feature allows a total volume to be set for fluid delivery. When that total volume is reached, a *TotVol Limit* advisory will alert the operator. This can be particularly useful for fluid-limited patients. The pump channels continue infusing as programmed (i.e., they do **not** change to a KVO rate).

1. Press **MORE OPTIONS** twice.
2. Press the **TotVol** softkey. The Total Volume Page (Figure 4-9) will appear on the display.



Stopped | Stopped | Stopped

TotVol = volume infused by
all pumps since cleared
25.0 ml over 00h 05m
TotVol Limit ____ m
Cleared at 7:35p 12 Nov 93
Currently 7:40p 12 Nov 93
Press Clear to Reset Volume

Figure 4-9: Total Volume (TotVol) Page

3. The total volume delivered by all channels since the total volume was last cleared can now be reviewed. If desired, the total volume can be cleared.
4. To clear the total volume, press the **Clear** softkey.

5. Press **Accept** to confirm your selection, or press **Recall** to return to the previous total volume value.
6. To set TotVol Limit, select it, use the arrow keys to set the total volume at which you wish to be notified, then press ACCEPT.

   If TotVol Limit is set in this way, the message *TotVol LIMIT* will appear across the Standard Display page and an audible advisory alarm will be emitted when the total volume delivered reaches the value set. To reset or clear the notification, press **MORE OPTIONS** twice, then TotVol, and either clear the current TotVol Limit value or re-enter a new value.
7. To exit the Total Volume Page and return to the Standard Display Page, press **STANDARD DISPLAY**.

4.18 Using the Time Softkey

This softkey is available on the Standard Display Page after pressing the **MORE OPTIONS** key twice. It allows the operator to review and change the time and date settings.

1. On the Standard Display Page, press **MORE OPTIONS** twice.
2. Press the **Time** softkey. This brings up the Instrument Time Page.
3. Use the **Select** softkey to select the time or date setting you wish to change.
4. Use the **▲ or ▼** softkey to change the value of the selected setting.
5. Press the **Accept** softkey to confirm the change, or the **Recall** softkey to recall the previous value.
6. Continue to select and change other settings in the same way.

NOTE: Time Display format can be set for either am/pm or for 24-hour International time.

4.19 Using the Batlog Softkey

A Battery History Log (**BatLog**) softkey is available on the Standard Display Page after pressing the **MORE OPTIONS** key twice. The **BatLog** softkey allows the operator to review the Battery History Log (BATLOG). Information on this display is intended to enable the Service Department to assess battery function. For a complete description of BATLOG, see the Technical Service Manual for the MedSystem III Multi-Channel Infusion Pump.

4.20 Using the DemoWD Softkey

The **DemoWD** softkey is available from the Standard Display Page by pressing **MORE OPTIONS** three times. While in-servicing new users, the instructor can use this softkey to demonstrate a Watchdog alarm. Press the **DemoWD** softkey and follow the directions on the screen display.

NOTE: A Watchdog alarm shuts down all three channels. Turn the pump off, then on again. Current settings are not affected by a Watchdog alarm.

5.0 Starting an Infusion

The following section describes the use of IVAC 28 and 25 series sets. It covers choosing the appropriate set, priming the set, inserting the set in the channel, beginning fluid delivery, and using the set for gravity flow.

5.1 Choosing the Appropriate Administration Set

The vented/unvented 28 and 25 series sets can be used with all types of bags or bottles.

- With bags, collapsible fluid containers, and vented bottles, the vent remains closed.
- With nonvented bottles the drip chamber vent should be in the open position.

Medications delivered via syringe require the use of the Half Set or Mini Set. Both of these sets have a 12-inch length of container-side tubing with a Luer fitting for attachment to a syringe.

5.2 Priming the Set

It is important to prime the set properly to eliminate air bubbles.

1. Inspect the packaging to make sure that it is intact and sealed. If it is not, do not use the set, as sterility may have been compromised.
2. Remove the set from the sealed package.
3. Close the regulating clamp and check the drip chamber vent for proper position.
4. Prepare the fluid container according to hospital policy and connect it to the IV set. Squeeze the drip chamber to fill it to fill line. Ensure that the cassette slideclamp is pushed in completely so that the tubing is not occluded.
5. Invert the cassette so that the tubing is up. Slowly open the regulating clamp and establish fluid flow to fully prime the set. Gently tap the cassette and 'Y'-sites as necessary to remove all air. Gently massage the pressure dome to ensure no air bubbles are trapped (Figure 5-1).

5.3 Inserting the Set into the MedSystem III Pump

1. Be sure that the instrument is ON before inserting the cassette.
2. Pull the cassette slide clamp all the way out to completely occlude the tubing.
3. Hold the cassette slide clamp with thumb and finger. Using a slightly upward (approximately 45° angle) and forward motion, guide cassette (tubing down) into the desired channel. Refer to Figure 5-2 for correct cassette position. Continue to push the cassette slide clamp until cassette snaps into the holder. Ensure that slide clamp is flush with cassette. Verify that the tubing collar is seated properly in the recess beneath the cassette. When the cassette is inserted properly, three beeps will sound.
4. Open the regulating clamp.

   NOTE: Close regulating clamp before removing set from pump.

5.4 Beginning Fluid Delivery

1. Set the channel with the desired infusion settings. Refer to Section 4.6, General Procedure for Setting or Changing Infusion Settings.
2. Press the **START/STOP** key to begin infusion.

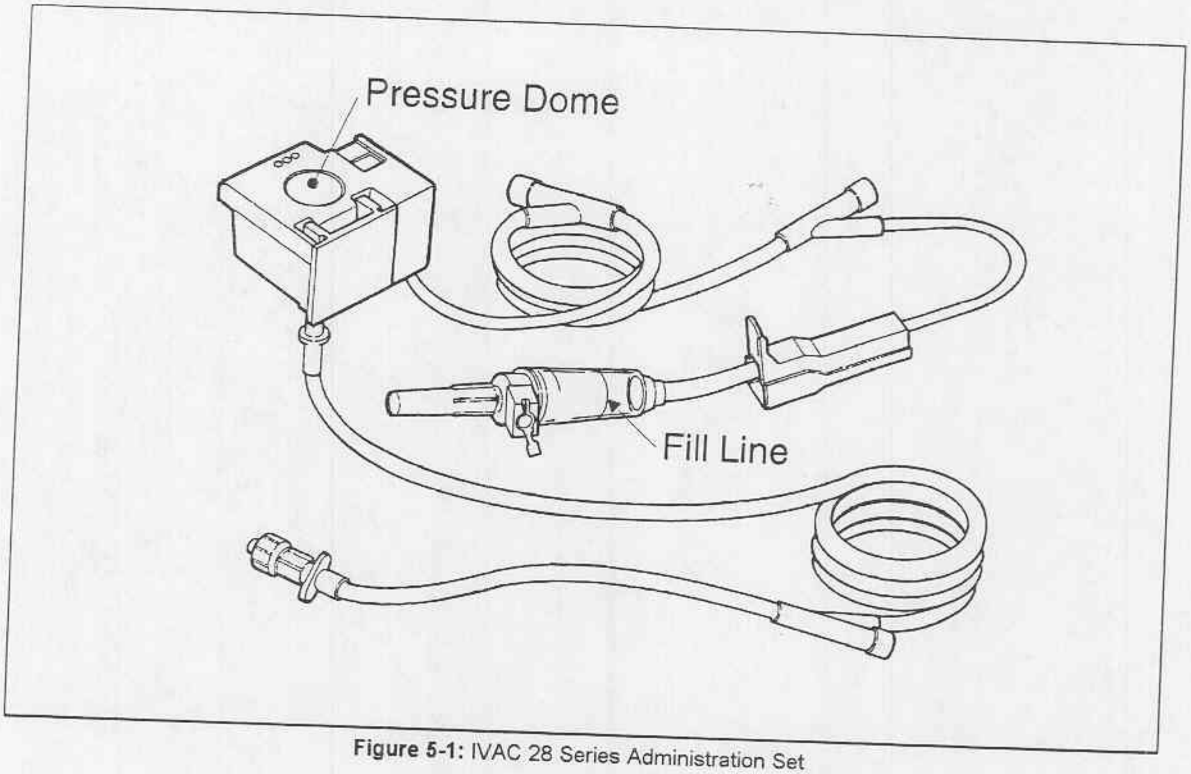
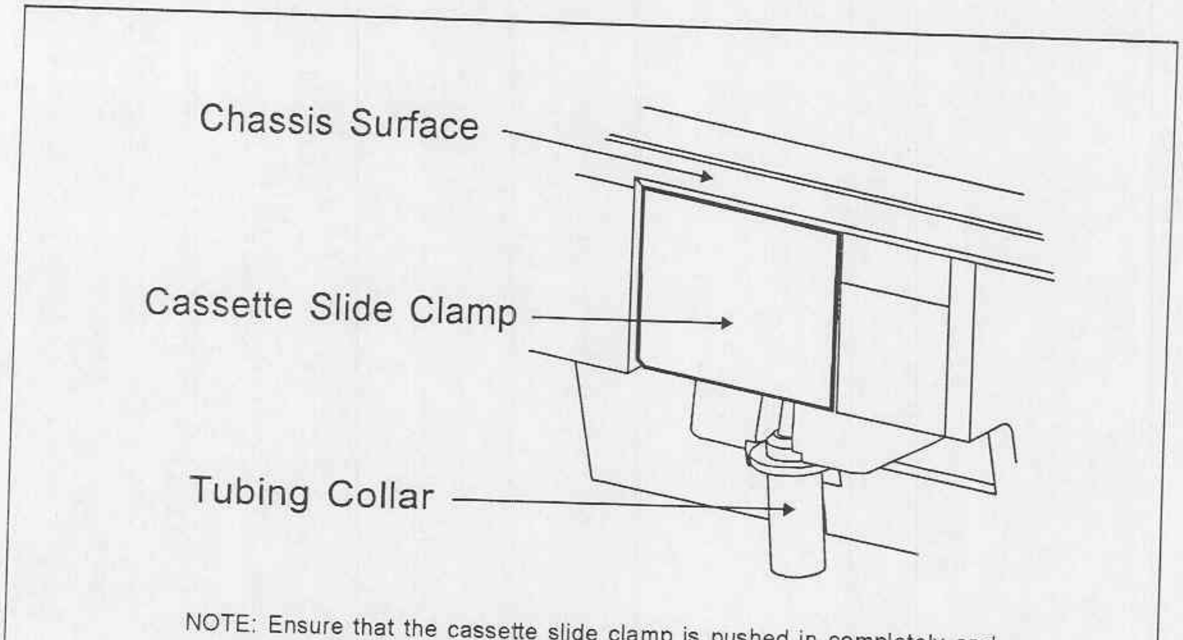

Pressure Dome
Fill Line

Figure 5-1: IVAC 28 Series Administration Set


Chassis Surface
Cassette Slide Clamp
Tubing Collar

NOTE: Ensure that the cassette slide clamp is pushed in completely and cassette is flush against chassis surface.

Figure 5-2: Cassette Slide Clamp Position

3. A green light will appear on the appropriate channel control key to indicate that the channel is infusing, and the channel status line will change to *Infusing*. Verify flow in the administration set as soon as **START** is pressed.

NOTE: Close regulating clamp before removing set from pump.

5.4.1 Using the Mini Set and Half Set with Syringes

1. Connect the syringe to the Luer fitting on the container-side tubing of the Half Set or Mini Set.
2. Ensure that the cassette slide clamp is pushed in completely so that the tubing is not occluded.
3. Invert the cassette so that the tubing is up. Slowly advance the syringe plunger to prime the set. Invert and gently tap the cassette and 'Y'-sites, as necessary, to remove all air. Gently massage the pressure dome to ensure no air bubbles are trapped in this area.
4. Pull out the cassette slide clamp while applying a small amount of pressure with the syringe. This action will occlude the tubing and properly position the cassette for insertion into the pump.

5.5 Gravity Flow (Stand-alone Use of Set)

The IVAC 28 and 25 series sets are designed for use with the MedSystem III Multi-Channel Infusion Pump, as well as for gravity flow stand-alone use. There are occasional situations in which the infusion must be delivered without a pump for a limited period of time (e.g., emergencies, unexpected transport, or difficult medical procedures).

1. Prime the IV set for normal use. Refer to Section 5.2, Priming the Set.

   NOTE: After the set is fully primed, it is unnecessary to pull out the cassette slide clamp. Flow is controlled by the regulating clamp. Do not use the slide clamp to regulate flow.

2. Perform venipuncture, if necessary, and attach the IV set.
3. Adjust the drop rate to the desired value, using the regulating clamp.

6.0 Supplemental Operations after Initial Setup

6.1 Changing the IV Container

1. Prepare the new IV container according to your institution's policy.
2. Press the **A**, **B**, or **C** key to select the channel for which you wish to change containers.
3. Press **STOP/START** to stop the infusion.
4. Close the regulating clamp.
5. Remove the spike or disconnect the Luer fitting from the old IV container.
6. Maintain aseptic technique and do not contaminate the spike or Luer fitting.
7. Insert the spike firmly into the new IV bag or bottle, or connect the Luer fitting to the new syringe.
8. Hang the container properly and ensure the drip chamber is filled to the indicated line.
9. If desired, press **Select** to highlight VR, and press **REPEAT** to recall the previous VR, or set a new VR and press **Accept**. Note that, if the setup is for Volume/Time infusions, pressing **REPEAT** will bring up the previous values for both VR and TR.
10. To clear VI, press **Select** to highlight it, record the VI value, then press **Clear** and **Accept**.
11. Open the regulating clamp and press **START/STOP** to begin the infusion.

6.2 Starting the Second or Third Channels

The procedure for beginning the second and third channels is the same as for the first:

1. Prime the tubing. Refer to Section 5.2.
2. Insert the cassette into the channel. Refer to Section 5.3.
3. Press channel control key **A**, **B**, or **C** to bring the desired second or third channel page up on the screen.
4. Select, enter, and accept the desired infusion settings.
5. Open regulating clamp.
6. Press **START/STOP** to begin the infusion.

6.3 Secondary/Piggy-Back Infusions (IVPB)

Refer to Dual Rate Mode (IVPB) General Operating Instructions in Section 9.0.

7.0 Alarms, Advisories, and Faults

The MedSystem III Pump uses alarms, advisories, and faults to alert the operator to important events or conditions affecting a specific channel, or the pump as a whole.

Whenever an alarm, advisory, or fault occurs, detailed information for addressing the condition is available on the Alarm Information Page. For a condition that affects a channel, the Information Page is accessed by pressing the specific channel control key (**A**, **B**, or **C**). For a condition that affects the whole pump, the Alarm Information Page is accessed by pressing the **STANDARD DISPLAY** key.

7.1 Alarms

Alarms indicate a condition that requires immediate attention. If the channel is infusing when an alarm occurs, fluid delivery stops.

An Alarm is indicated in the following manner:

- The word *Alarm* appears on the channel status line.

The name of the alarm is displayed on the channel screen (or across the whole screen if the entire pump is affected).

- A red light blinks rapidly on the **A**, **B**, or **C** channel control key (or all three keys if the whole pump is affected).
- A series of four beeps is repeated.

7.2 Advisories

Advisories indicate conditions about which the operator should be aware, but they may not be as critical as alarms. If a channel is infusing when an advisory occurs, fluid delivery continues or switches to the KVO rate setting for the current Device Type. The green running lights on the channel control keys remain unaffected.

Examples of advisory conditions include *Infusion Complete* (when VR = 0), *Low Battery*, and *Pump Not In Use* (when a channel with a cassette in place has not been started within 2 minutes). An advisory is indicated in the following manner.

- The name of the advisory is displayed on the channel screen.
- A red light blinks **slowly** on the **A**, **B**, or **C** key (or on all three keys if the whole instrument is affected).
- A series of two-toned double beeps is repeated.

7.3 Faults

Faults indicate that a malfunction has been detected by the instrument software. Faults could lead to performance that is out of specification, uncontrolled or potentially dangerous to the patient. If a channel is infusing when a Fault occurs, fluid delivery stops.

A fault is indicated in the following manner:

- The word *Fault* appears on the channel status line.
- *Pump Out Of Order* is displayed on the channel screen (or across the whole screen if the entire pump is affected).
- A series of "European Police Siren" beeps is repeated.

1. Certain Fault alarms can be cleared, others cannot.
2. For Faults that can be cleared, the Alarm Information Page has both a **RETRY** and a **BIOMED** softkey.

3. Faults that may be caused by transient events can be cleared by pressing the **RETRY** softkey, available from the Alarm Information Page. If the condition causing the Fault persists, however, the Fault will recur and the **BIOMED** softkey should be pressed to disable the channel for servicing.
4. Pressing **BIOMED** disables the channel for servicing. The status line on a disabled channel reads *Service*. The Alarm Information Page for Faults shows the name of the Fault, and lists a service code number to be used when servicing the pump.
5. For Faults that cannot be cleared, no **RETRY** softkey is provided. The only choice the operator has, therefore, is to place the channel (or all three channels, in the case of an instrument Fault) into Service by pressing the **BIOMED** softkey.

7.4 Alarm, Advisory, and Fault Softkeys

The following softkeys are specific to Alarms, Advisories, and Faults.

QUIET - available on the Standard Display Page and the Alarm Information Page. This softkey allows the operator to silence Alarm and Fault beeps for one 2-minute period, and Advisory beeps for repeated 2-minute periods.

> **NOTE:** If two or three channels alarm simultaneously, **QUIET** will silence the beeps for 2-1/2 or 3 minutes, respectively.

CANCEL - available on the Alarm Information Page, this softkey allows the operator to clear an alarm, leaving the channel or whole pump stopped. Prior infusion settings are not affected.

RETRY - Available on the Alarm Information Page for Faults. When a Fault has occurred that can be cleared, pressing the **RETRY** softkey may allow the operator to re-establish normal operation of a channel.

ClrAir - Available on the Alarm Information Page. When an Air-in-Line Alarm has occurred, this softkey is used to push an air bubble past the air sensor. The bubble can then be removed in accordance with hospital procedure.

BIOMED - Available on the Alarm Information Page for Faults. The **SERVICE** softkey allows an operator to disable a channel or the whole pump for servicing when a Fault occurs that cannot be cleared. It can also be used to disable a channel after a Fault has occurred that apparently was not due to a transient cause.

> NOTE: Once Biomed has been pressed, the channels cannot be retried. Technical Service is required.

CONFIRM - Available on the Alarm Information Page for Check Fluid-side alarm. Pressing **CONFIRM** tells the MedSystem III Pump that the operator has confirmed that no occlusion is present. Flow should be verified. A ✓ will appear on the Standard Display Page as a reminder to the operator to verify flow.

Table 7-1 lists Alarms, Advisories, and Faults in alphabetical order, along with a description of their causes and a discussion of the corrective actions for each. Use of each softkey discussed above is detailed in the table.

TABLE 7-1
ALARMS, ADVISORIES AND FAULTS

Visual Display	Type	Audio	Cause	Corrective Action
Air In Lower Tubing	Alarm	Four beeps	The pump channel has detected several small bubbles with a total volume exceeding its air-in-line threshold setting. Each bubble is smaller in size than the air-in-line threshold setting for the given Device Type. These bubbles may be due to improper priming, to excessive outgassing (generally related to placement of the instrument significantly higher than the patient and a low rate of 10 ml/h or less), or to a leak in the set at some point above the air-in-line sensor (the black unit in which the tubing is recessed).	Reprime the set if necessary, and verify that there are no leaks in the system. If the instrument is more than 12 inches above the patient and the rate is less than 10 ml/h, move the instrument to or near patient level. Note that a ClrAir softkey is available on the Alarm Information page. Each press causes the pump to rapidly deliver a small pulse of fluid (less than 0.2 ml/pulse). This can be used to push an air bubble past the air sensor. As soon as the bubble is past the sensor, the instrument will beep three times, and delivery can be resumed by pressing the START/STOP key. The air bubble can then be removed according to hospital procedure. Fluid volume infused by the ClrAir softkey is recorded by the appropriate VR and VI counters. The ClrAir softkey can be used a maximum of five times for a given alarm.
Air In Line	Alarm	Four beeps	The pump channel has detected air in the fluid pathway of the cassette. **NOTE:** Because the air sensor adds together small bubbles within a window of up to 3 ml in volume, also check the tubing downstream from the cassette.	Verify that the tubing collar is fully seated in the recess beneath cassette. Note that the ClrAir softkey is available on the Alarm Information page. Each press causes the pump to rapidly deliver a small pulse of fluid (less than 0.2 ml/pulse). This should push the air bubble past the air sensor. As soon as the bubble is past the sensor, the pump will beep three times, and delivery can be resumed by pressing the START/STOP key. Fluid volume infused by the ClrAir softkey is recorded by the appropriate VR and VI counters. The ClrAir softkey can be used a maximum of five times for a given alarm. If necessary, remove cassette and manually clear air from the fluid delivery pathway, in accordance with hospital policy. Reinstall cassette and press the START/STOP key to resume the infusion, or press the CANCEL softkey to clear the alarm. **NOTE:** Residue buildup in the groove of the black ultrasound air sensor pod located just beneath the cassette can sometimes lead to nuisance air-in-line alarms. This groove should be cleaned periodically with a cotton swab and isopropyl alcohol.

TABLE 7-1
ALARMS, ADVISORIES AND FAULTS (CONTINUED)

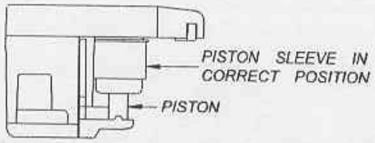
Visual Display	Type	Audio	Cause	Corrective Action
Battery Depleted	Alarm	Four beeps	Insufficient battery power to operate instrument. Infusion has stopped. The instrument will shut itself off within 5 minutes.	Attach the AC adapter immediately, and restart desired channels—or turn the instrument off.
Blank screen with all lights on	Watchdog alarm	Continuous beep	Various.	Turn instrument off, then on again, and restart any infusing channels. If the condition causing the alarm was transient, the instrument should continue to function normally. If the Watchdog alarm recurs, or if the instrument cannot be turned on, service is required. After a Watchdog alarm occurs, the next time the instrument is turned on, the Instrument Information page will display a BIOMED code number to assist with servicing. If the instrument is turned off a second time, then on again, there will be no code number; but, it will be in the Event Log.
Cassette Jammed	Alarm	Four beeps	Cassette jammed in holder or cassette piston sleeve slipped off cylinder. May also be due to mechanical problem with cassette  CASSETTE - SIDE VIEW	Remove cassette, and check cassette piston sleeve. Reposition sleeve if necessary, and reinsert cassette. If alarm recurs, change cassettes. If alarm recurs with several cassettes, have pump channel serviced.
Cassette Not Latched	Alarm	Four beeps	The pump channel detected that the cassette has become partially disengaged from the holder during an infusion.	Make sure the cassette is fully latched within the holder, then press the START/STOP key to restart infusion, or press **Cancel** softkey to clear the alarm.

TABLE 7-1
ALARMS, ADVISORIES AND FAULTS (CONTINUED)

Cassette Removed	Alarm	Four beeps	The cassette was removed during an infusion.	Reinstall the cassette and press the START/STOP key to restart infusion, or press D/C to clear the alarm and discontinue channel use.
Check Air Sensor	Advisory	Two beeps	The pump channel has detected air in the fluid pathway of the cassette, and the channel has not yet started infusing.	Verify tubing collar is fully seated in the recess beneath cassette. If necessary, remove cassette and manually clear air from fluid delivery pathway according to hospital policy. Reinstall cassette and initiate infusion by pressing the START/STOP key. An alternative to cassette removal is to press the ClrAir softkey on the Alarm Information page. Each press causes the pump to rapidly deliver a small pulse of fluid (less than 0.2 ml/pulse). This should push the air bubble past the air sensor. As soon as the bubble is past the sensor, the pump will beep three times. The air bubble can then be removed according to hospital procedure. Fluid volume infused by the ClrAir softkey is recorded by the appropriate VR and VI counters. The ClrAir softkey can be used a maximum of five times for a given advisory. **NOTE:** Residue buildup in the groove of the black ultrasound air sensor pod located just beneath the cassette can sometimes lead to nuisance Check Air Sensor advisories. This groove should be cleaned periodically with a cotton swab and isopropyl alcohol.
Check Fluid Side	Alarm	Four beeps	A possible flow restriction has been detected on the upstream (fluid side) line.	Check the upstream line for (1) closed vent on the set, if it is attached to a nonvented container; (2) closed regulating clamp; (3) kinked tubing; or (4) other possible restrictions to fluid flow. Once the condition has been corrected, press the START/STOP key to resume the infusion. If no occlusion was found, the alarm may have been caused by a viscous solution or some other resistance during the cassette fill stroke. Pressing CONFIRM on the Alarm Information page tells the MedSystem III pump that the operator has confirmed that no occlusion is present. Pressing START/STOP will then resume infusion. Flow should be verified, since the alarm will not recur if an occlusion was still present at the time CONFIRM was pressed (subsequent occlusions should, however, generate an alarm). A ✓ will appear on the Standard Display as a reminder to the operator to verify flow. The ✓ will clear with a new cassette on the first cassette fill stroke following installation or if the instrument is turned off for 10 minutes.

TABLE 7-1
ALARMS, ADVISORIES AND FAULTS (CONTINUED)

Visual Display	Type	Audio	Cause	Corrective Action
Faulty Cassette	Alarm	Four beeps	Cassette may be dirty, inoperative, or the cassette sensor in the cassette holder may not be functioning properly.	Reinsert the old cassette, or install a new cassette. If the alarm recurs with several cassettes, the cassette sensor may need service. Press the appropriate channel key (A,B, or C), then press the BIOMED softkey to end use of the channel. Technical service is required.
Fluid-Side Occluded	Alarm	Four beeps	A flow restriction has been detected on the upstream (fluid side) line.	Check the upstream line for (1) closed vent on the Universal set if it is attached to a nonvented container, (2) closed roller clamp; (3) kinked tubing; or (4) other possible restrictions to fluid flow. Once the condition has been corrected, press the START/STOP key to resume infusion, then verify flow; or press the appropriate channel key (A, B, or C), then press the CANCEL softkey to clear the alarm. If no occlusion was found, the alarm may have been caused by a viscous solution or some resistance during the cassette fill stroke.
Infusion Complete VR=0	Advisory	Two beeps	The Volume Remaining setting has gone to zero, and the channel has switched into KVO mode (unless current rate is <KVO rate setting).	To resume infusion, press the appropriate channel key (A,B, or C) twice, then enter a new Volume Remaining. If you wish to repeat the prior VR settings, press the REPEAT key, then press ENTER. Once settings are as desired, press the START/STOP key to resume infusion.
Low Battery	Advisory	Two beeps	The main batteries have 30 minutes or less of power remaining.	Press QUIET to silence the advisory for 15 minutes. The Standard Display will continue to display "Low Battery". Attach to AC power as soon as possible.
Patient-side Occluded	Alarm	Four beeps	A flow restriction has been detected in the downstream (or patient-side) line.	Check the downstream line for kinks, closed clamps, closed stopcocks, plugged filters, site occlusions, etc. Once the condition has been corrected, press the START/STOP key to resume the infusion or press the **CANCEL** softkey to clear the alarm..
Power System Failure	Advisory	Two beeps	The internal power system of the pump has failed. The AC power is cut off internally. The instrument will shut off within 5 minutes.	Immediately replace the instrument and have it serviced.
Pump Does Not Home	Fault	Siren beeps	The cassette latch is unable to position itself correctly when the pump is first turned on.	Check the cassette holder for obstructions (e.g., a piece of packing foam). Press the appropriate channel key (A,B, or C), then press RETRY to attempt recovery. If the fault recurs, press the BIOMED softkey to end use of the affected channel. Technical service is required.

TABLE 7-1
ADVISORIES, ALARMS AND FAULTS (CONTINUED)

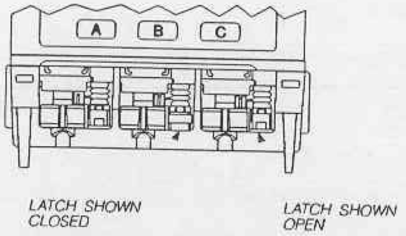
Visual Display	Type	Audio	Cause	Corrective Action
Pump Latch Closed	Alarm	Four beeps	The pump latch is in the closed position, or is broken. This alarm is also sometimes caused by pointing the instrument into direct sunlight when there is no cassette installed. 	Open the pump latch for the selected channel. It must always be in the open position to accept a cassette. If the pump latch opens and closes loosely, it is broken and needs servicing. If a pump latch is broken, technical service is required. Press the appropriate channel key (A,B, or C), then press the BIOMED softkey to end use of the affected channel. Technical service is requried. If an alarm occurs because the pump is pointed into direct sunlight, adjust the angle of the pump so that the latch is out of the sunlight. The alarm should then stop.
Pump Motion Hindered	Fault	Siren beeps	The movement of the pump motor has been hindered, either by a physical obstruction, or by internal damage.	Press the appropriate channel key (A, B or C), then press the RETRY softkey to attempt recovery from the fault. Remove the cassette and check the position of the piston sleeve, and reposition if necessary (for a diagram, see "Cassette Jammed Alarm"). If the condition recurs, press the BIOMED softkey to end use of affected channel . Technical service is required.
Pump Not In Use	Advisory	Two beeps	This callback advisory indicates that the channel has had a cassette in place for 2 minutes without infusion being started. **NOTE:** This advisory does not occur in Operating Room Device Types.	Press the appropriate channel key (A, B, or C), then press the START/STOP key to start the infusion. If you do not want to start the infusion, but want to leave the cassette in place without causing the *Pump Not In Use* advisory, press STNDBY to place the pump channel in the Standby mode. Simply removing the cassette will also clear this advisory.

TABLE 7-1
ADVISORIES, ALARMS AND FAULTS (CONTINUED)

Visual Display	Type	Audio	Cause	Corrective Action
Pump Shut Off: Low Power	Advisory	No beeps	This message appears on the User Information page when the instrument is turned on. It indicates that the instrument shut itself off after a Battery Depleted alarm was ignored.	This message clears automatically. The instrument should be attached to AC power and should not be operated on batteries again until a minimum recharge time of 10 hours has elapsed.
Pump Shut Off: Not In Use	Advisory	No beeps	This message appears on the Information page when the instrument is turned on. It indicates that the instrument shut itself off after a Battery Depleted alarm was ignored.	This message clears automatically when the pump is turned on again. No additional corrective action is required.
Rate/Vol Settings Cleared	Alarm	Four beeps	This alarm occurs when a change in Device Type is made, and the rates and/or volumes are incompatible with the new Device Type.	Re-enter the cleared rates and/or volumes, then press START to resume the infusion.
TotVol Limit	Advisory	Two beeps	The total volume infused by all three channels has reached the *TotVol Limit*. All pump channels continue normal infusion (they do not switch to KVO rates).	To reinitiate the *TotVol Limit*, press the MORE OPTIONS key twice, then the TotVol softkey to access the TotVol page. Either clear the current total volume value, or reset a higher value for *TotVol Limit*. To cancel the advisory, press the STANDARD DISPLAY key to access the Advisory Information page, then press CANCEL. To permanently disable the advisory, press the MORE OPTIONS key twice, then press the TotVol softkey. Disable TotVol Limit by selecting the TotVol Limit line, pressing CLEAR, then pressing ACCEPT.

8.0 Additional Operating Modes for the Fluid Delivery System

Each channel on the MedSystem III Pump may run a different application or "mode." This section discusses how to enter different channel modes. In this software version (3.5 series) there are two choices, Basic Mode and Dual Rate Mode. To change the mode for a channel, perform the following:

1. Press the desired channel control key (**A**, **B**, or **C**) to access the individual Channel Page, then press the **MORE OPTIONS** key. A softkey labeled **Mode** will appear.
2. Press the **Mode** softkey. This will bring up a menu of additional channel modes (Figure 8-1). Note that the currently selected mode is marked by an asterisk.

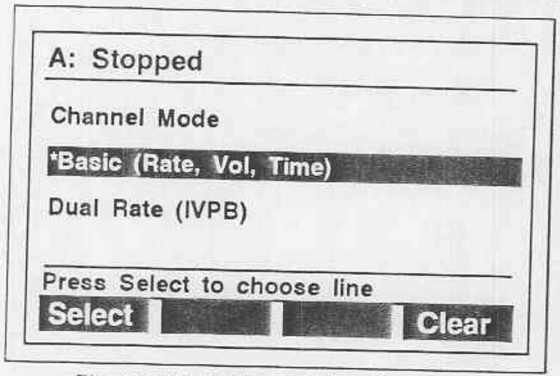
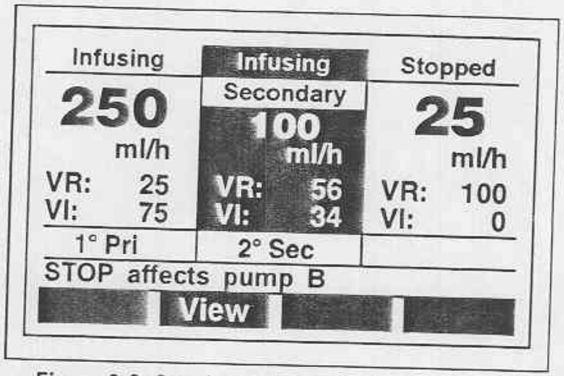


Figure 8-1: Additional Modes Menu Page

3. Press the **Select** softkey to highlight the desired mode.
4. When the selected mode is highlighted, press the **Accept** softkey. Note that the asterisk will move to the new mode after **Accept** is pressed.
5. Press the **STANDARD DISPLAY** key to return to the Standard Display Page or the channel control key (**A**, **B**, or **C**) to return to the Channel Page for setting infusion parameters.

NOTE: When any mode other than *Basic* is running on any channel, the *Device Type* line on the Standard Display will alternate between a display of the current Device Type and a display of current mode settings for channels in modes other than Basic (Figure 8-2).



Infusing	Infusing Secondary	Stopped
250 ml/h	100 ml/h	25 ml/h
VR: 25	VR: 56	VR: 100
VI: 75	VI: 34	VI: 0
1° Pri	2° Sec	

STOP affects pump B

Figure 8-2: Standard Display for All Channels Programmed in Different Mode Settings

Your institution may have elected to lock certain modes into given channels so that they cannot be changed. This is done using the Field Maintenance Software (FMS). Refer to Section 11.0.

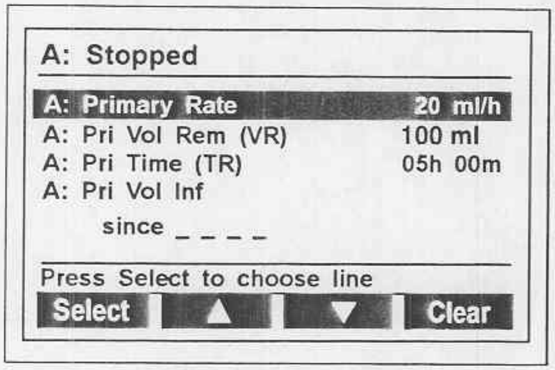
9.0 Secondary/Dual Rate Mode (IVPB): General Operating Instructions

This mode has been designed to support automatic secondary infusions or "piggybacking", but can also be used for loading doses, fluid challenges, and other applications where an automatic rate change is desired.

9.1 Accessing Dual Rate Mode (IVPB)

1. Verify that the desired channel is in Dual Rate Mode by checking the Standard Display Page for the *1°Pri* or *2°Sec* display (Figure 8-2). If it is not in Dual Rate Mode, refer to section 8.1, Changing Channel Modes.
2. Press the desired channel control key (**A**, **B**, or **C**). The Primary Page should appear (Figure 9-1). All settings on this page refer to the Primary infusion only, and are equivalent to the settings on the Channel Page for Basic Mode.

NOTE: When the channel mode is changed from Basic to Dual Rate, or back, Basic settings will always equal Primary settings. If the channel is infusing in Basic or Primary at the time of the change, the infusion is not interrupted. The channel mode cannot be changed while a Secondary is infusing.



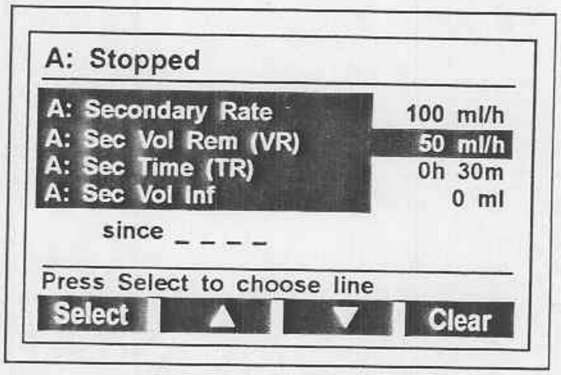
A: Stopped

A: Primary Rate 20 ml/h
A: Pri Vol Rem (VR) 100 ml
A: Pri Time (TR) 05h 00m
A: Pri Vol Inf
since _ _ _ _

Press Select to choose line

Figure 9-1: Primary Page

3. Press the **MORE OPTIONS** key, then press the **2°Sec** softkey. The Secondary Page should appear (Figure 9-2). All settings refer to the secondary infusion only.



A: Stopped

A: Secondary Rate 100 ml/h
A: Sec Vol Rem (VR) 50 ml/h
A: Sec Time (TR) 0h 30m
A: Sec Vol Inf 0 ml
since _ _ _ _

Press Select to choose line

Figure 9-2: Secondary Page

9.2 Using Dual Rate Mode

Physical setup for automatic Secondary delivery requires a check valve set for the Primary line, and a Secondary set with a needle (16-gauge is recommended) connected to its upper Y-site.

1. During a Primary infusion, press the selected channel control key. Press the **MORE OPTIONS** key, then the **2°Sec** softkey. The Secondary Page will appear.
2. Enter a Secondary rate and VR. For automatic Secondary infusion, do not set a Secondary rate higher than 275 ml/h. At higher rates, some sympathetic flow from the Primary container may occur. For other types of infusions, there are no rate restrictions.
3. If desired, clear the Secondary VI.
4. For automatic Secondary infusions, ensure that the Primary container is placed below the Secondary container.

This can be done by hanging the Primary container on one of the instrument's fluid container hooks, or by using the plastic hanger that comes with the Secondary set.

5. Press **START** to initiate the Secondary infusion.

   NOTE: A tone will sound and a prompt will display *Switching to Secondary Rate.*

6. Press **STANDARD DISPLAY** and verify that the Secondary infusion has been initiated. During a Secondary infusion, the screen is reverse highlighted (Figure 8-2), and the word *Secondary* is above the rate. Verify flow from the Secondary container.
7. When the Secondary VR counts down to zero (VR = 0), the infusion will automatically switch back to the Primary rate. If desired, the instrument can be configured so that an audible advisory occurs at the time of the transition. Refer to Section 9.6, Secondary Complete Advisory.
8. To repeat the Secondary Infusion with the same VR, access the Secondary Page. Refer to Section 9.1, paragraph 3. If VR = 0, press the **REPEAT** softkey. This will bring up the previously set VR and TR, if the setup is for Volume/Time infusions. Press **Accept** to set this value as the new VR.
9. Press **START** to initiate the new Secondary infusion.

9.3 Running Basic Infusions while in Dual Rate Mode

Any channel in Dual Rate Mode will support basic Rate/Volume/Time infusions. This means that if typical use of the instrument involves both Basic and automatic Secondary infusions, all channels can be placed in Dual Rate Mode as a standard setting.

For basic infusion, the Primary Page operates in exactly the same way as the basic Channel Page.

9.4 Switching between Primary and Secondary Infusions

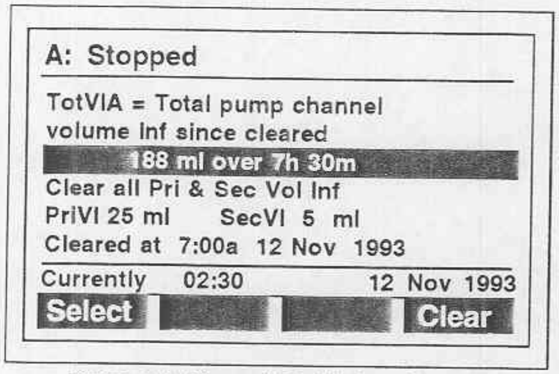
There may be occasions when it is desirable to discontinue a Secondary infusion prior to completion, and switch back to the Primary rate. There may also be occasions when it is desirable to restart an interrupted Secondary line.

- Switching from Secondary to Primary: While Secondary is infusing, press the desired channel control key (**A, B,** or **C**). The Secondary Page will appear. Press **MORE OPTIONS** and the **1°Pri** softkey, and then press **START/STOP**. A tone will sound and the prompt line will display *Switching to Primary Rate.*
- Switching from Primary back to an interrupted Secondary: While Primary is infusing, press the selected channel control key (**A**, **B**, or **C**). The Primary Page will appear. Press **MORE OPTIONS** and the **2°Sec** softkey will appear. Press the **2°Sec** softkey, and then press **START/STOP**. A tone will sound and the prompt line will display *Switching to Secondary Rate.*

9.5 Channel Total Volume Page

This is a record-keeping Page for the Total Volume Infused values for a given channel (Primary + Secondary).

1. Access either the Primary or Secondary channel Page.
2. Press **MORE OPTIONS** to bring up the channel **TotVI** softkey (**TotVI**, **A**, **B**, or **C**), then press the **TotVI** softkey to display the Channel Total Volume Page (Figure 9-3).



A: Stopped

TotVIA = Total pump channel volume Inf since cleared

188 ml over 7h 30m

Clear all Pri & Sec Vol Inf

PriVI 25 ml SecVI 5 ml

Cleared at 7:00a 12 Nov 1993

Currently 02:30 12 Nov 1993

Figure 9-3: Channel Total Volume Page for Channel A

3. To clear the Channel Total Volume, press the **Clear** softkey, then press **Accept**.
4. To exit the Channel Total Volume Page, press either **STANDARD DISPLAY**, or the channel control key (**A**, **B**, or **C**).

NOTE: The total volume infused may not equal the sum of the displayed *PriVI* and *SecVI* values, since they can be cleared separately.

NOTE: The line reading *Clear all Pri & Sec Vol Inf* will not be present if this option is disabled. The option to clear all VI values from the Channel Total Volume Page is enabled under Change Mode Settings, which is accessible by the **Config** softkey.

9.6 Secondary Complete Advisory (Optional)

This audible advisory notifies the user that the *Secondary Infusion* has completed and that the channel has changed back to *Primary* settings. This may be useful when several successive Secondary infusions are to be given.

1. While on the Standard Display Page, press the **MORE OPTIONS** key once, then press the **Config** softkey.
2. Press **Select** to highlight *Change Mode Settings*, and press **Accept**.
3. Press **Accept** again to access *Change Dual Rate Settings*.
4. Press **Select** to highlight *IVPB Switch Advisory*.
5. Use the ▲ or ▼ softkeys to set *Yes*, then press **Accept**.
6. Press the **STANDARD DISPLAY** key to return to the Standard Display.

When a Secondary Complete Advisory occurs, press the appropriate channel control key and follow the displayed prompts.

NOTE: This feature will not be present if your hospital has chosen to disable this option.

10.0 Cleaning and Maintenance

10.1 Cleaning

Cleaning is an important part of maintenance for the MedSystem III Multi-Channel Infusion Pump.

> ***CAUTION:*** *To prevent possible fluid ingress, DO NOT invert the instrument when spraying cleaning solutions.*

10.1.1 Instrument Exterior

Routinely clean the exterior surfaces of the instrument. Use a cloth dampened with warm water and a mild, nonabrasive, nonstaining standard hospital disinfectant or a detergent (i.e., commercially available dishwashing liquid). Dilute the disinfectant or detergent with water. Isopropyl alcohol may be used to wipe the housing exterior. Avoid contact with the LCD screen.

> **NOTE:** For cleaning solutions, refer to the Environmental Services, Central Service, or Infection Control Departments in your facility for further information on appropriate cleaning agents.

10.1.2 Lower Housing and Pumping Mechanism

> ***WARNING:*** *When cleaning the optomodule, use EXTREME CARE to avoid damage to the valve actuators. If valve actuators are damaged, an unrestricted flow condition could result.*

To access these components, first remove the lower plastic housing by depressing the four black release tabs in the upper corners. Next, pull straight down (Figure 10-1). A small soft-bristled brush helps in cleaning the pump latch mechanism and linkages. If the slide link or pump latch mechanisms stick, spray with an acceptable cleaning solution (Figure 10-2). To loosen severely contaminated mechanisms, let cleaning solutions permeate for an extended time. Thoroughly dry the mechanisms after cleaning, using clean pressurized air.

10.1.3 Air-in-line Sensor

The air-in-line sensor tubing recess must be free of debris, dirt or dried solutions. Wipe the tubing recess (Figure 10-3) with a nonabrasive cloth, pad or swab moistened with isopropyl alcohol. Remove excess alcohol with a dry, lint-free swab.

10.1.4 Cassette Sensors (Optomodule)

Clean the cassette sensors (optomodule) with water or a very diluted mild detergent solution (Figure 10-4). Wipe the surfaces dry with a lint-free swab.

10.2 Annual Maintenance

It is recommended that annual maintenance be performed on the instrument. Such maintenance should be performed as outlined in the Technical Service Manual for the MedSystem III Multi-Channel Infusion Pump.

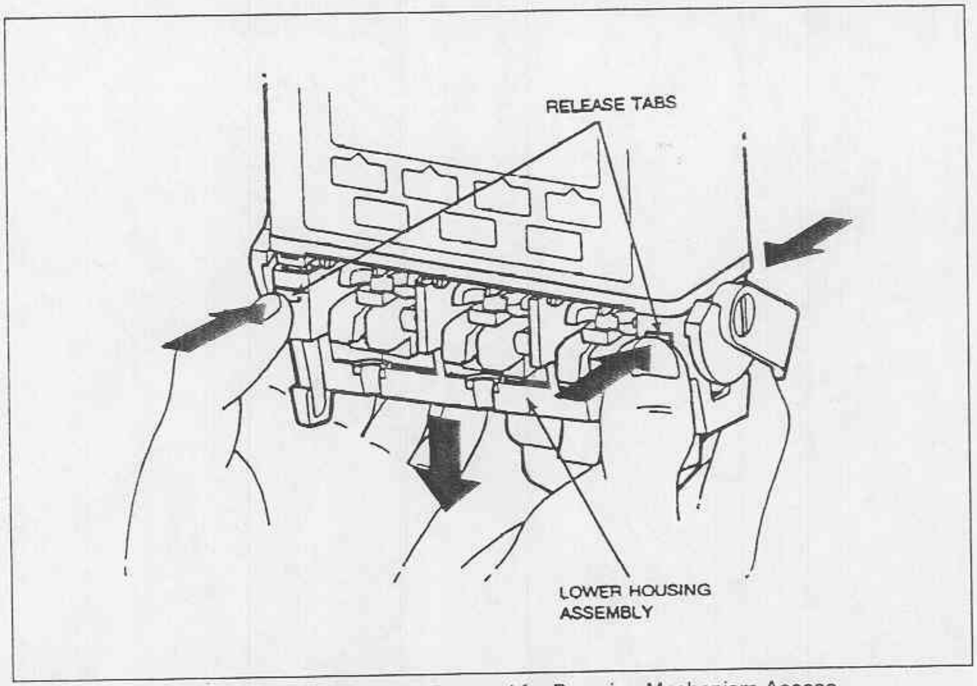

RELEASE TABS
LOWER HOUSING ASSEMBLY

Figure 10-1: Lower Housing Removal for Pumping Mechanism Access

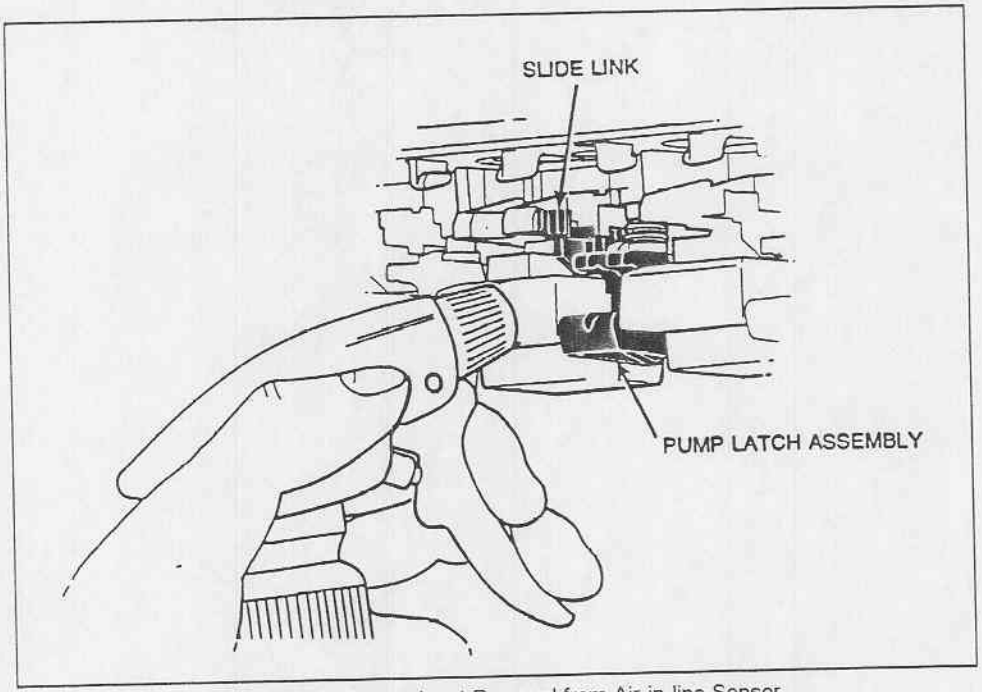

SLIDE LINK
PUMP LATCH ASSEMBLY

Figure 10-3: Contaminant Removal from Air-in-line Sensor

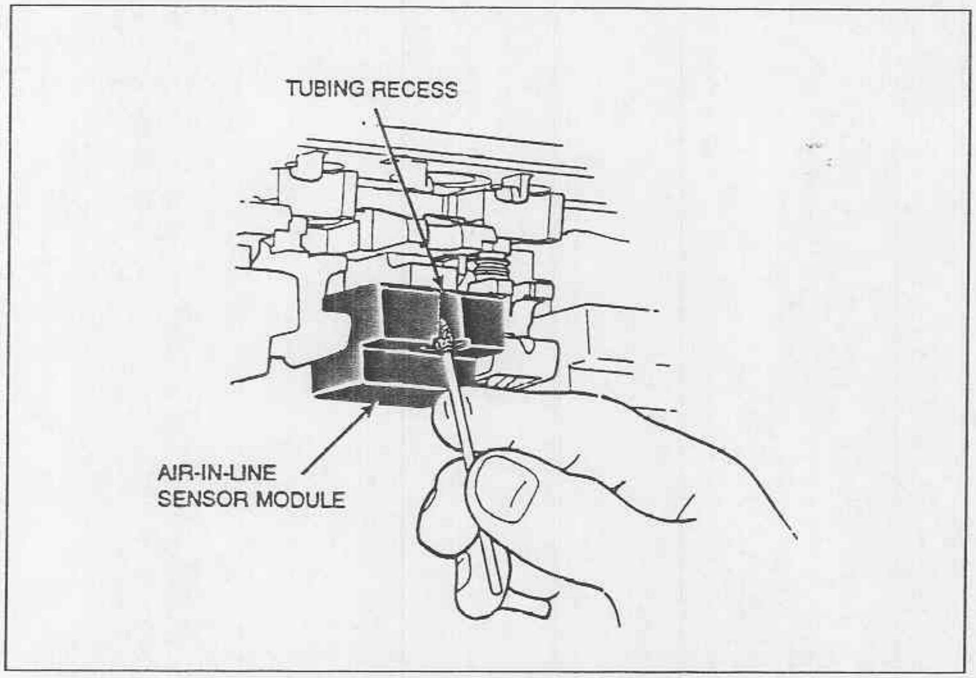
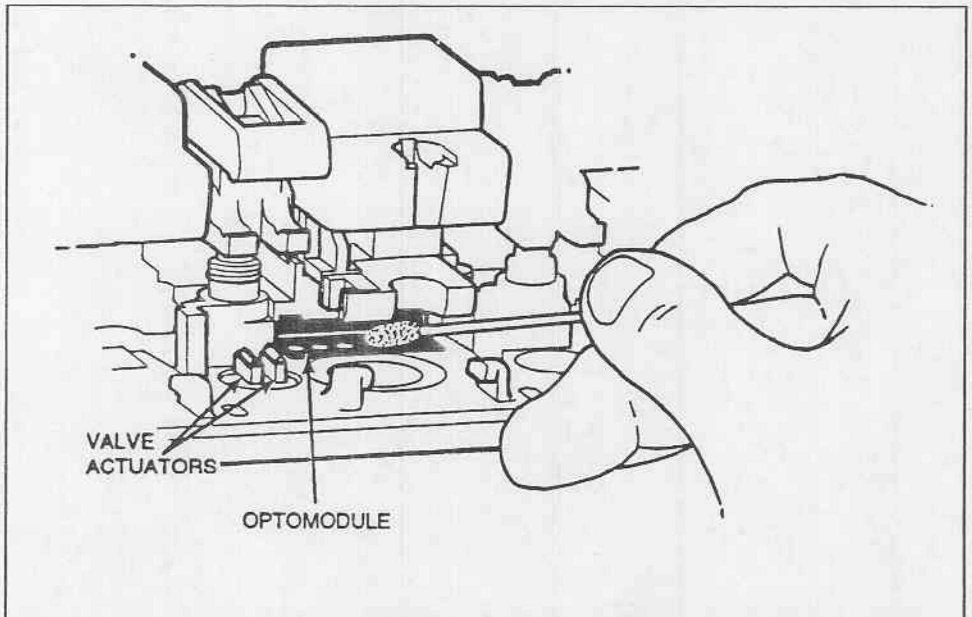

TUBING RECESS
AIR-IN-LINE SENSOR MODULE

Figure 10-3: Contaminant Removal from Air-in-line Sensor


VALVE ACTUATORS
OPTOMODULE

Note: Instrument is rotated upside down for easier access to the cassette sensors.

Figure 10-4: Contaminant Removal from Optomodule

11.0 Field Maintenance Software

11.1 Field Service Programming

The MedSystem III Multi-Channel Infusion Pump has been designed to allow the customizing of certain parameters within each of the different Device Types. One set of parameters can be changed with Field Maintenance Software, either at the factory service center or by qualified Biomedical Engineering Department personnel. Certain additional parameters can be customized only at the factory service centers.

11.2 Customization Using Field Maintenance Software (FMS)

Field Maintenance Software supports customization of the following parameters:

- Maximum and Incremental Pressures
- Air-in-Line Alarm Threshold
- Maximum Volume Remaining, both Primary and Secondary
- Maximum Rate, both Primary and Secondary
- KVO Rate
- Lockout for changing Device Type
- Availability of *ALL* setting for Volume Remaining in the Operating Room Device Type
- User Information Line
- Mode Lockout
- Default Secondary setup
  - Volume/Rate or Volume/Time
- Instrument Serial Number
- Special Note Page (up to five lines of text which appear whenever the instrument is turned on after a user-specified date).
- OFF Delay: The number of seconds you must hold the **OFF** key in to turn the instrument off (the factory setting is 1 second).
- Alarm Volume Ramping: Disabling/ Enabling automatic increase in alarm tone volume if an alarm has not been addressed within 1 minute.
- Battery Installation dates: Date of NiCd and Lithium battery installation.
- Enable/Disable the **ClrAir** softkey

11.3 Additional Customization

For customization of other MedSystem III Multi-Channel Infusion Pump operating parameters, contact IVAC Infusion Systems Clinical Engineering Department.

APPENDIX A

Technical Data

General

Standards	ANSI/AAMI ES1, 7-85 UL No.544 CSA C22.2, No. 125, Risk Class 2G

Physical

Outer Casing	Polycarbonate ABS alloy
Dimensions (H x W X D)	7.875 x 6.000 x 2.100 inches 20.00 x 15.24 x 2.10 cm
Weights	Instrument: 3 lb., 9 oz. (1.61 kg) Universal Pole Clamp: 1 lb., 9 oz. (0.7 kg)
Operating Temperature	10° - 40°C
Maximum Storage Temperature	55°C (For optimum battery life, the preferred storage temperature is < 35°C.)

Performance

Rate Range	0.1-999 ml/h (per channel)
Volume Range	0.1-9999 ml (per channel)
KVO Rate Range	0.1-20.0 ml/h
Battery Types	• Main: Rechargeable NiCd Battery Pack • Memory Back-up: Nonrechargeable Lithium
Required Administration Sets	IVAC 28 and 25 series Administration Sets
Gravity Flow Protection	The administration set tubing is automatically occluded when the cassette is removed from the pump, thereby minimizing unrestricted flow.

Electrical

Power Consumption	6W AC power. Use only the following power source: AC Adapter, Model 1550.
NiCd Battery Specifications	Running time with full charge: If battery is fully charged, minimum of 6 hours running time to *Battery Depleted* alarm, with all channels running at 125 ml/h and 2 minutes of backlighting per hour. The battery retains 80% of its capacity after 500 charging cycles. The battery retains 90% of its capacity after 3 months of continuous AC charging.
AC Adapter Power Cord	8.5 feet (2.59m) in length with hospital grade AC adapter.
Fuses	3A fast-blow internal
Ground Continuity	Maximum 0.1 ohm (Meets UL and CSA leakage requirements.)
Leakage Current	Maximum 100 microamps (per UL 544)

APPENDIX B

Abbreviations and Acronyms

General

µl	microliter
AAMI	American Association of Medical Instrumentation
AC	alternating current (electrical power)
ANSI	American National Standards Institute
COMM	receptacle label on the communications panel
CSA	Canadian Standards Association
DC	direct current (battery power)
ECRI	The Emergency Care Research Institute
FMS	Field Maintenance Software
I.D.	identification
Inf	infused
IV	intravenous
IVPB	intravenous piggy-backing
KVO	keep vein open
LCD	liquid crystal display
LED	light-emitting diode
ml/h	milliliter per hour
N/A	not applicable
NiCd	nickel-cadmium
Pri	Primary
PriVI	Primary volume infused
psi	pounds per square inch

Sec	Secondary
SecVI	Secondary volume infused
UL	Underwriters Laboratories, Inc.
VDE	Verein Deutscher Electrotechniker
VI	volume infused
Vol	volume
VR	volume remaining

Softkey Designations

BatLog	Battery History Log
ClrAir	Clear Air
Cntrst	Contrast
Config	Configuration
DemoWD	Demonstrate Watchdog
NextPg	Next Page
STNDBY	Standby
TotVI	Total Volume Infused
TotVol	Total Volume

Warranty

IVAC Corporation (hereinafter referred to as "IVAC") warrants that:

A. Each new IVAC instrument (controller, pump or peripheral instrument) is free from defects in material and workmanship under normal use and service for a period of one (1) year from the date of delivery by IVAC to the original purchaser.

B. Each new accessory is free from defects in material and workmanship under normal use and service for a period of ninety (90) days from the date of delivery by IVAC to the original purchaser.

If any product requires service during the applicable warranty period, the purchaser should communicate directly with IVAC headquarters (San Diego, CA) to determine the appropriate repair facility. Except as provided otherwise in this warranty, repair or replacement will be carried out at IVAC's expense. The product requiring service should be returned promptly, properly packaged and postage prepaid by purchaser. Loss or damage in return shipment to the repair facility shall be at purchaser's risk.

In no event shall IVAC be liable for any incidental, indirect or consequential damages in connection with the purchase or use of any IVAC product. This warranty shall apply solely to the original purchaser. This warranty shall not apply to any subsequent owner or holder of the product. Furthermore, this warranty shall not apply to, and IVAC shall not be responsible for, any loss or damage arising in connection with the purchase or use of any IVAC product which has been:

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(b) altered in any way so as to affect, in IVAC's judgment, the product's stability or reliability;

(c) subjected to misuse, or negligence, or accident, or which has had the product's serial or lot number altered, effaced or removed;

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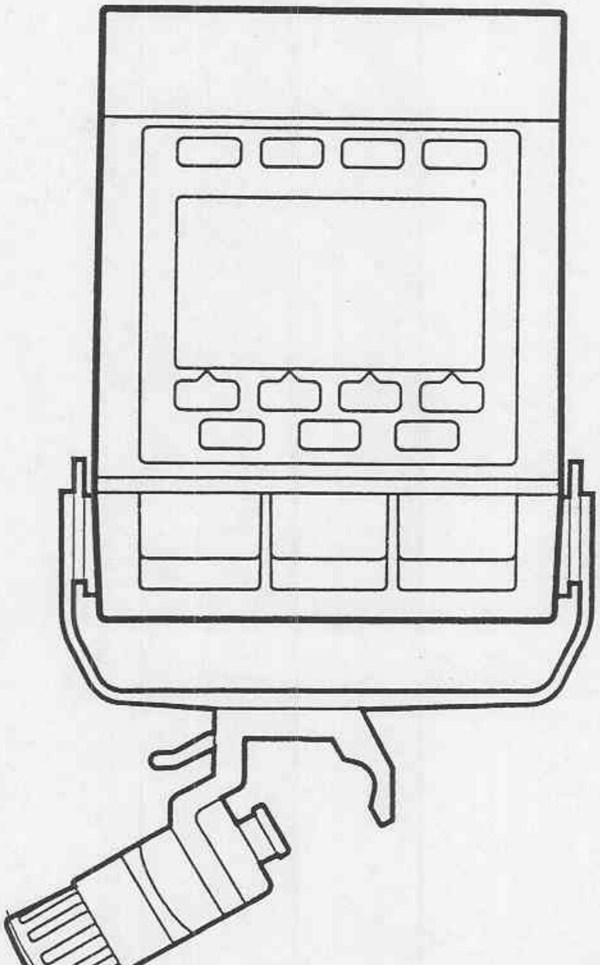
IVAC® Corporation

Technical Service Manual
MedSystem III™ Infusion System



IVAC® Corporation

MedSystem III™

Models 2860 and 2863

Multi-Channel Infusion Pump

Technical Service Manual

May, 1995

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PATENT INFORMATION

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FOR U.S.A. AND FOREIGN PATENTS

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This service manual is subject to change without notification. For current technical information please call Clinical Engineering at (800) 854-7128 ext. 6325, or write IVAC Corporation, 10300 Campus Point Drive, San Diego, CA 92121-1579, attention Clinical Engineering.

Printed in the U.S.A.

Manual part number 139981

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(a) repaired by anyone other than an authorized IVAC service representative;
(b) altered in any way so as to affect, in IVAC's judgment, the product's stability or reliability;
(c) subjected to misuse, or negligence, or accident, or which has had the product's lot or serial number altered, effaced or removed;
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See packing inserts for international warranty, if applicable.

Foreword

The purpose of this Technical Service Manual is to enable personnel who are experienced and trained in the analysis and servicing of microprocessor-controlled instrumentation to maintain, troubleshoot, and repair the MedSystem III™ Infusion System.

All KEY NAMES are written in regular type as they appear on the computer keyboard or instrument. Screen messages are written in italics.

This manual contains guidelines for user and patient safety. We suggest you consult the Safety Summary, Appendix H, for general precautions before beginning any maintenance or repair on the instrument.

Specific advisory and cautionary information is contained throughout the manual where applicable.

Contacting IVAC Technical Support

If you need assistance with the installation or operation of MedSystem III equipment, contact your local IVAC Account Manager.

If you need technical assistance, call toll free (800) 854-7128 extension 6325.

If you need Customer Service or Parts, call toll free (800) 482-4822.

MAIN TABLE OF CONTENTS

Chapter 1: INTRODUCTION

Chapter One contains general information about the MedSystem III and about the manual contents.

Chapter 2: PRINCIPLES OF OPERATION

Chapter Two provides an overview of the system and details the principles of operation for the MedSystem III.

Chapter 3: SYSTEM FUNCTIONAL TESTS

Chapter Three describes the functional tests recommended prior to using the instrument, after repair or calibration, and annually as part of preventive maintenance.

Chapter 4: MAINTENANCE

Chapter Four provides procedures for properly maintaining the instrument to keep it operating efficiently and to detect the need for repair or adjustment.

Chapter 5: CALIBRATION

Chapter Five contains references for calibrating and adjusting the instrument to maintain optimum performance.

Chapter 6: TROUBLESHOOTING

Chapter Six contains troubleshooting procedures to help isolate and identify causes of possible malfunctions. References are included to guide service personnel to the proper procedures in the event of a malfunction.

Chapter 7: REPAIR

Chapter Seven contains detailed step-by-step procedures for disassembling and reassembling the instrument, and for removing and installing replaceable components and subassemblies.

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Appendix A: TECHNICAL SPECIFICATIONS

This appendix contains the physical, electrical, and mechanical specifications of the instrument.

Appendix B: REQUIRED EQUIPMENT AND SUPPLIES

This appendix is a general listing of required equipment and supplies, as well as figures depicting special tooling and equipment.

Appendix C: RECOMMENDED SPARE PARTS

This appendix lists recommended spare parts, as well as the order numbers for each.

Appendix D: BATTERY HISTORY LOG

This appendix provides details about the Battery History Log, which contains information useful in performing battery operating time functional checks, annual maintenance, and troubleshooting.

Appendix E: ILLUSTRATED PARTS LIST

This appendix is an illustrated listing of instrument parts, as well as the order numbers for each.

Appendix F: LIST OF ABBREVIATIONS AND ACRONYMS

This appendix provides a list of the abbreviations and acronyms used in the manual.

Appendix G: GLOSSARY OF TERMS

This appendix defines some words and terms which may not be well-known to the user.

Appendix H: SAFETY SUMMARY

This appendix provides general safety precautions that are not included within the text of the manual.

Appendix I: SCHEMATICS

This appendix provides board assemblies and schematics for the main electronics assembly and the power supply, along with an interconnect diagram.

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Chapter 1
Introduction

1.0 System Introduction

The MedSystem III ™ Infusion System is a small, three-channel, microprocessor-based fluid delivery device capable of controlled and monitored infusion via intravenous, intra-arterial, or subcutaneous routes. Each of the three channels provides the equivalent of an independent infusion device able to pump fluid from syringes, bottles or bags located above or below the level of the instrument. Each channel operates via a disposable infusion cassette. Channels are individually controlled and programmed for infusion tasks. Infusions are monitored to detect occlusions, air in a line, and low power. The electronic and software functions are also monitored using built-in self-tests to help ensure safe operation.

The design and construction of the MedSystem III Infusion System provides the following features:

- Upgradeable software
- Low maintenance, no lubrication
- Calibration through software
- CMOS surface-mount circuitry
- Modular design
- Easy disassembly/reassembly

Maintenance, calibration, and customization features are available through the use of MedSystem III Field Maintenance Software (FMS). This software allows the user to communicate with the infusion system through its RS-232 communications port, using an IBM-PC compatible computer.

1.1 Objectives

The purpose of this manual is to enable qualified service personnel to maintain, troubleshoot, and repair the MedSystem III Infusion System. This manual has been prepared under the presumption that the user is experienced and trained in the analysis and servicing of microprocessor-controlled instrumentation. It is recommended that a factory authorized training program precede any actual disassembly or repair of the instrument.

In light of the state-of-the-art technology used, proprietary nature of the software, and specialized equipment required in the replacement of individual components, it is recommended that troubleshooting and repair be performed only to the module or replaceable part level. Replaceable parts are items that can be replaced with minimal or no unsoldering of circuit components.

It is suggested that a complete overview of all features, functions, and operating procedures be obtained. This can be done by consulting the MedSystem III Directions For Use (DFU) and the MedSystem III Field Maintenance Software Directions for Use, in addition to this Technical Service Manual.

1.2 Using This Manual

This manual includes information on the Model 2860 and Model 2863 pumps. Throughout the manual, if no model number is specified, the information pertains to both models. Where information is specific to one model, that model number is called out.

The Technical Service Manual is specifically structured to facilitate ease of use. Each chapter is clearly defined in the table of contents. Chapter 2 discusses the principles of operation. Chapter 3 discusses functional tests and how to complete them. Chapter 4 provides both routine and annual maintenance procedures. Chapter 5 describes procedures for calibrating the instrument. Chapter 6 discusses troubleshooting, and includes a number of tables to be used as guides during the troubleshooting process. Chapter 7 is a detailed procedure for repairing the instrument.

The appendices included are:
A - Technical Specifications
B - Required Equipment and Supplies
C - Recommended Spare Parts
D - Battery History Log
E - Illustrated Parts List
F - List of Abbreviations and Acronyms
G - Glossary of Terms
H - Safety Summary
I - Schematics

All instructions, special notes, and illustrations are integrated within the text of each chapter to minimize the need to refer to multiple pages during a single operation.

It is suggested that the Safety Summary, Appendix H, be reviewed before beginning any type of service on the instrument.

1.3 New Instrument Checkout

1.3.1 Physical Inspection

- Before unpacking, check the shipping container for damage that may have affected contents. Report any shipping damage to Customer Service.
- Check to ensure that all accessories are included in the package.
- Check for any physical damage to the instrument or accessories. If any is found, report it to Customer Service.

1.3.2 Functional Tests

Refer to your institution's policies for specific requirements regarding inspection and testing of incoming equipment before use.

Recommended functional tests are given in Chapter 3 of this manual.

As a minimum, the following steps should be performed before use.

- Charge battery for 14 hours.
- Perform electrical safety checks.
- Turn instrument on to verify normal power-up and operation of LEDs, display, and audio.

1.4 Customizing Parameters

Certain MedSystem III operating parameters can be customized using FMS. If customizing is desired, refer to the MedSystem III Directions For Use and the FMS Directions For Use.

1.5 Points of Contact

For parts, disposables, or repair service, telephone:

Customer Service Department
1-800-482-4822

For technical information, assistance with repair, or technical training, telephone:

Clinical Engineering Department
1-800-854-7128 extension 6325

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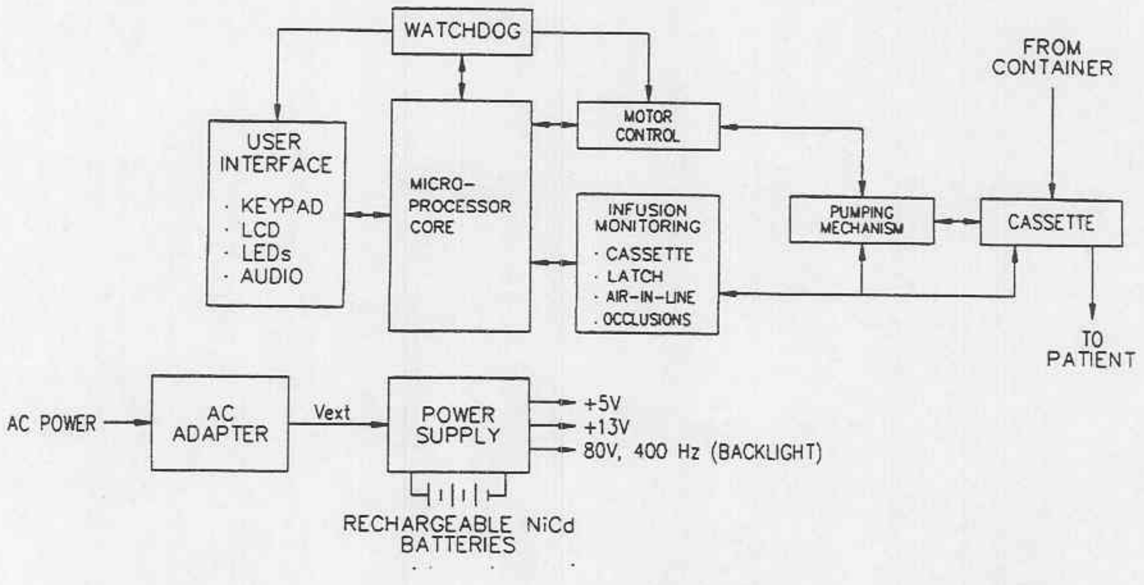
Chapter 2

Principles of Operation

2.0 System Overview

The MedSystem III Infusion System provides safe and accurate fluid delivery for a wide range of operating conditions. A block diagram of the overall system is shown in Figure 2-1. A cassette provides a sterile pathway for delivery of fluids and includes sensor interfaces for monitoring infusions. Each channel contains an independent pumping mechanism, motor control system, and infusion monitoring system. Using the keypad and LCD, the operator can program the instrument to monitor infusion. Based on Rate and Volume Remaining, the pumping mechanism is controlled by a microprocessor. Various sensors monitor the infusion to detect proper cassette placement, occlusions, and air in the line. A watchdog circuit ensures that the microprocessor properly executes the software program. If the sensors or watchdog circuit detect a condition that is inappropriate, the infusion is stopped, and the operator is alerted by the red LEDs, an audible tone and a message on the LCD screen. The system is powered by either a rechargeable NiCd battery pack or DC power from the MedSystem AC Adapter. Power consumption is minimized by using complimentary metal oxide semiconductor (CMOS) components and low duty-cycle operation.

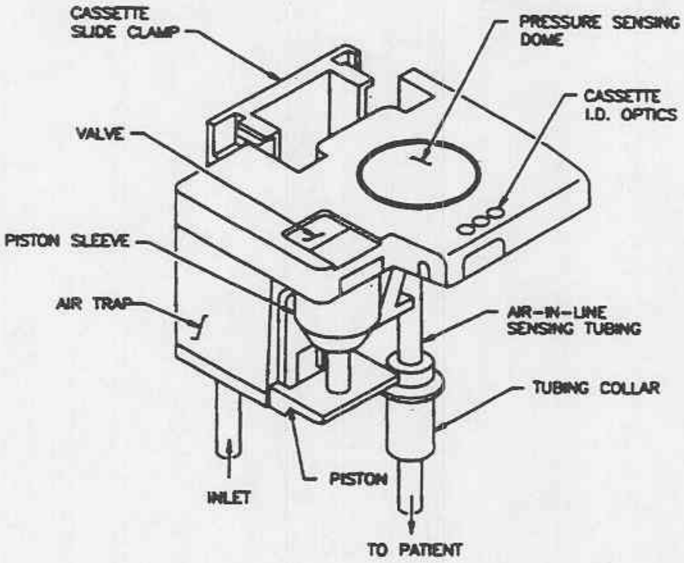
Figure 2-1. Block Diagram of MedSystem III Infusion System


WATCHDOG
FROM CONTAINER
USER INTERFACE
· KEYPAD
· LCD
· LEDs
· AUDIO
MICRO-PROCESSOR CORE
MOTOR CONTROL
INFUSION MONITORING
· CASSETTE
· LATCH
· AIR-IN-LINE
. OCCLUSIONS
PUMPING MECHANISM
CASSETTE
TO PATIENT
AC POWER
AC ADAPTER
Vext
POWER SUPPLY
+5V
+13V
80V, 400 Hz (BACKLIGHT)
RECHARGEABLE NiCd BATTERIES

The main functional components of the cassette are shown in Figure 2-2. The cassette contains an elastomeric membrane between two rigid plastic parts. The membrane is exposed for valving and for sensing pressure. The pumping chamber is sealed by a silicone piston sleeve in which the plastic piston is inserted. The piston stroke volume is approximately 80 microliters. Air is sensed in the outlet tubing section between the cassette and tubing collar.

The collar seats in the lower housing of the instrument and holds the tubing securely in the sensor. To detect cassette placement, the optomodule sensor in the chassis of the instrument senses the identification (I.D.) optics of the cassette. The I.D. optics also provide a code that can be used in future applications for identifying different cassette types. The cassette slide clamp latches the cassette to the instrument chassis, engages the slide link to close the pump latch, and automatically occludes the tubing when the cassette is removed from the instrument.

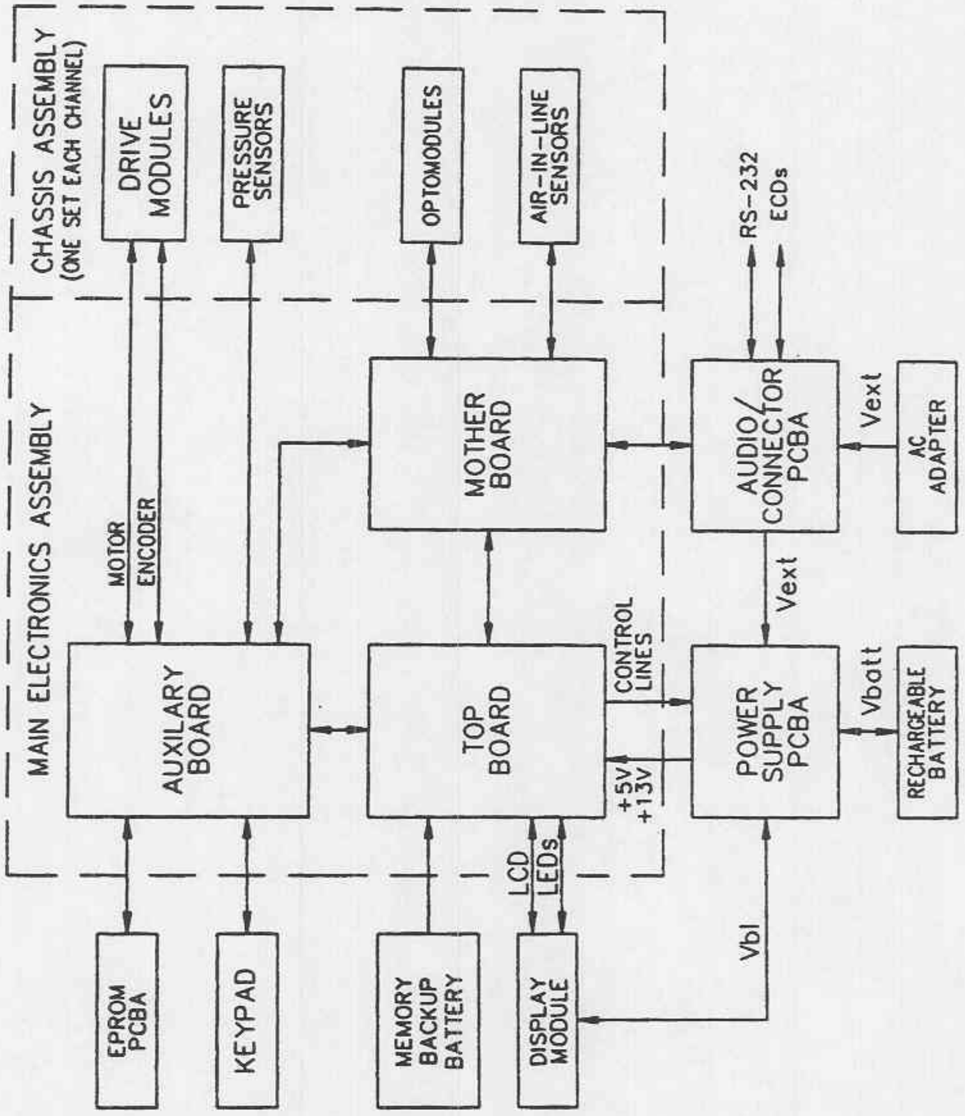
Figure 2-2. ***Cassette Main Functional Components***



The physical configuration of the electronics is shown as a block diagram in Figure 2-3. The microprocessor core, motor control, and watchdog circuits are included in the main electronics assembly (MEA), together with interface circuits for the user interface and infusion monitoring systems. In the Model 2860, the MEA consists of three boards: (1) the mother board, (2) the auxiliary board, and (3) the top board. The power supply printed circuit board assembly (PCBA) and memory backup battery connect to the MEA via the top board. In the Model 2863, the MEA consists of three boards: (1) the mother board, (2) the buffer board, and (3) the top board. The power supply printed circuit board assembly (PCBA) connects to the MEA via the top board. The memory backup battery connects directly to the MEA.

In both models, the drive modules and monitoring sensors mounted on the chassis also connect to the MEA. The audio/connector PCBA and keypad are mounted on the main housing. The audio transducer and connectors for external power, RS-232 communications, and empty container detectors (ECD) are included on the audio/connector PCBA; however, the ECD option has been discontinued. The display module contains three green and three red LEDs and a super-twist dot matrix LCD with an electroluminescent backlighting panel. The LCD backlighting is powered by an 80V AC inverter on the power supply PCBA.

Figure 2-3. ***Block Diagram of Electronics Physical Configuration (Model 2860 only)***

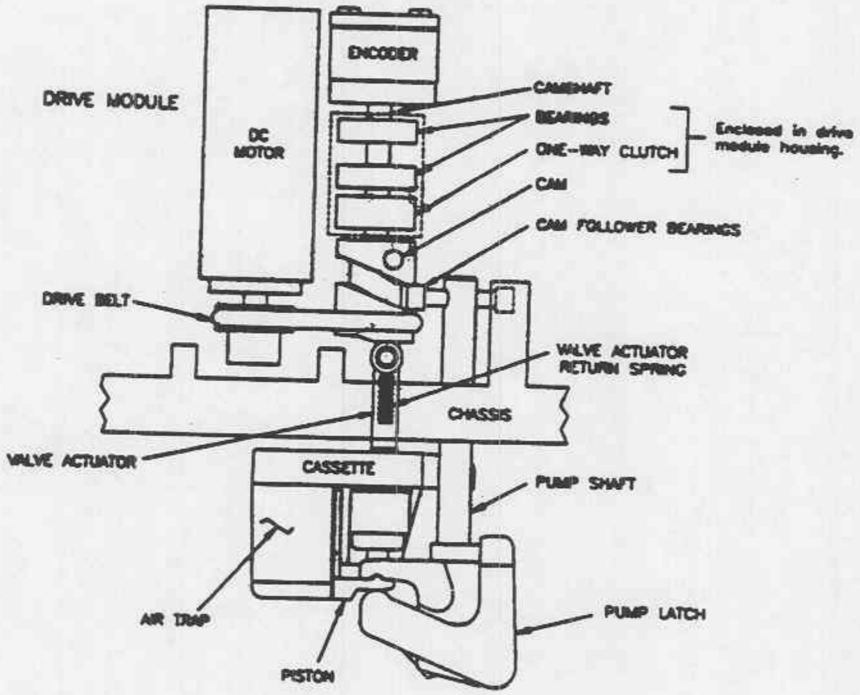

CHASSIS ASSEMBLY
(ONE SET EACH CHANNEL)
DRIVE MODULES
PRESSURE SENSORS
OPTOMODULES
AIR-IN-LINE SENSORS
RS-232
ECDs
MAIN ELECTRONICS ASSEMBLY
MOTOR
ENCODER
MOTHER BOARD
AUDIO/CONNECTOR PCBA
Vext
AC ADAPTER
Vext
AUXILARY BOARD
TOP BOARD
CONTROL LINES
+5V
+13V
POWER SUPPLY PCBA
Vbatt
RECHARGEABLE BATTERY
LCD
LEDs
Vbl
EPROM PCBA
KEYPAD
MEMORY BACKUP BATTERY
DISPLAY MODULE

2.1 Fluid Delivery

> **WARNING**
>
> *Proper pump latch and valve actuator heights are necessary for correct operation of the instrument. Heights must be adjusted after replacing certain drive components. Removal of drive components or the pump latch should only be performed by trained personnel.*

Fluid is delivered to the patient by a reciprocating piston pump powered by a drive module. Each channel has an independent drive module mounted to the chassis. The valves of the pump are formed by actuators in the chassis compressing the elastomeric membrane in the valve area of the cassette. The cassette piston is moved back and forth by the pumping mechanism. A functional diagram of this system is shown in Figure 2-4. The valve actuators and cassette piston are operated by a cam in the drive module. Return springs ensure that the valve actuators follow the cam face properly. The cassette piston is captured by the pump latch which is connected to the pump shaft. Follower bearings attached to the pump shaft engage a track in the side of the cam, causing the pump latch and cassette piston to reciprocate when the cam is rotated. A direct current (DC) motor in the drive module rotates the cam via an elastomeric belt. The drive module housing includes cam shaft bearings for support, and a one-way clutch to prevent backdriving when power is removed from the motor. An encoder on the cam shaft provides position information for controlling fluid delivery.

Figure 2-4. Functional Diagram of Pumping Mechanism


ENCODER
DRIVE MODULE
CAMSHAFT
BEARINGS
DC MOTOR
ONE-WAY CLUTCH
Enclosed in drive module housing.
CAM
CAM FOLLOWER BEARINGS
DRIVE BELT
VALVE ACTUATOR RETURN SPRING
CHASSIS
VALVE ACTUATOR
CASSETTE
PUMP SHAFT
AIR TRAP
PUMP LATCH
PISTON

NOTE: Arrangement and scaling of components may be different than actual configuration. This is for clarity.

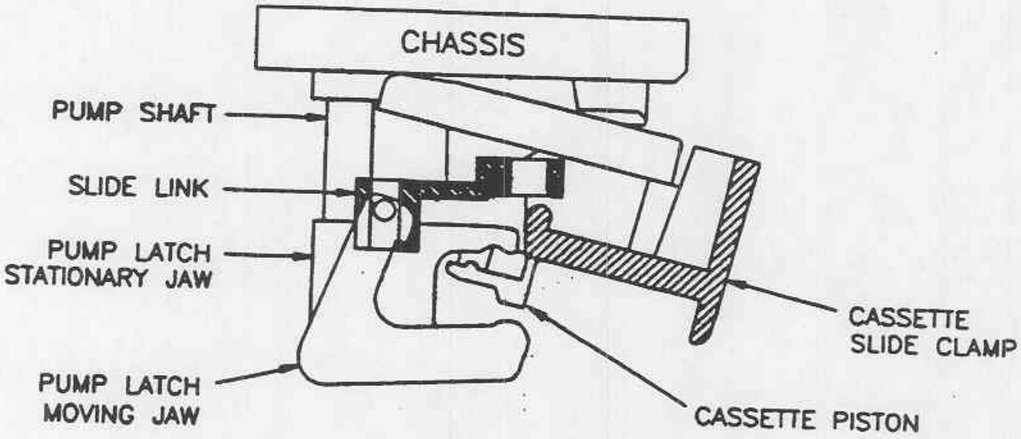
Cassette installation prepares the system for fluid delivery. When the instrument is turned on and a cassette is not installed, the cam is rotated to the "home" position at the beginning of the fill stroke. The home position, which is indicated by a signal from the encoder, allows the pump latch to easily capture the cassette piston. During installation (see Figure 2-5), a tab on the cassette slide clamp engages a slot in the front of the slide link. The movable jaw of the pump latch has a post on the side that engages a slot in the back of the slide link. As the cassette slide clamp is pushed in, the tab pushes the slide link, which, in turn, closes the movable jaw of the pump latch. The cassette piston is now held firmly by the pump latch. Tabs on the slide clamp also engage holders in the chassis to hold the cassette body firmly against the chassis. This forces the valve actuators against the cassette valve area, closing off the fluid pathway. Pushing the cassette slide clamp in toward the chassis also unclamps the patient-side tubing, allowing fluid to be delivered to the patient. The tubing collar is then secured in the air-in-line sensor by the operator. Sensors in the optomodule detect cassette placement and pump latch closure. This, together with the air sensor's detection of fluid, signals that the channel is ready for fluid delivery.

Pumping begins by positioning the valves to fill the pumping chamber. The outlet valve is closed and the inlet valve is opened. The pumping chamber is then filled by retracting the piston (see Figure 2-6A). Once the chamber is filled, the cam closes the inlet valve and opens the outlet valve. Opening and closing of valves is overlapped to ensure the fluid pathway between the container and patient is always closed. Fluid is then delivered by advancing the piston toward the bottom of the chamber (see Figure 2-6B).

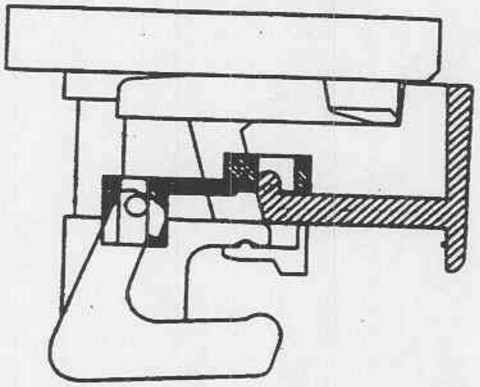
Delivery rate is regulated by varying the duty cycle of the motor, based on feedback from the encoder. An encoder on the cam shaft has several functions, including: (1) sensing whether the pump channel is in the fill stroke or in the delivery stroke, (2) sensing the incremental motion during fluid delivery, and (3) determining the home position. The delivery stroke is divided into 160 increments, which results in a volume resolution of 0.5 microliters. The microprocessor reads a counter that accumulates encoder counts for each channel. The infusion rate, programmed by the user, is converted to required encoder counts. From the required and measured encoder counts, a feedback control algorithm in the software determines the appropriate motor pulse width which is the duration that the motor is turned on.

The controller performs these calculations every three seconds. The calculated pulse width is loaded into a programmable interval timer that controls the drive voltage circuit. A drive voltage of 5V is used for a rate of 275 ml/h or less, and 13V is used for rates greater than 275 ml/h. Valving and pump filling phases are controlled by logic circuits, using an optical encoder signal that marks the delivery stroke. This signal is referred to as DEL. This closed-loop system accurately maintains fluid delivery rate at the programmed value despite the varying loads that are experienced during infusions.

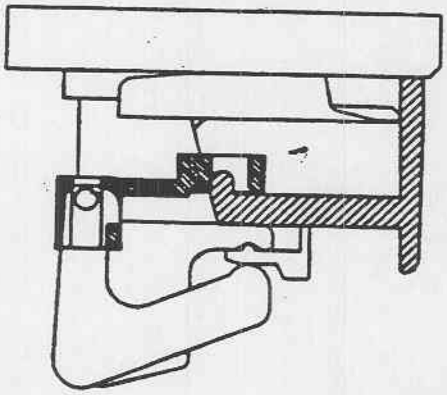
Figure 2-5. Cassette Installation


CHASSIS
PUMP SHAFT
SLIDE LINK
PUMP LATCH STATIONARY JAW
PUMP LATCH MOVING JAW
CASSETTE SLIDE CLAMP
CASSETTE PISTON

A. INSERT CASSETTE.

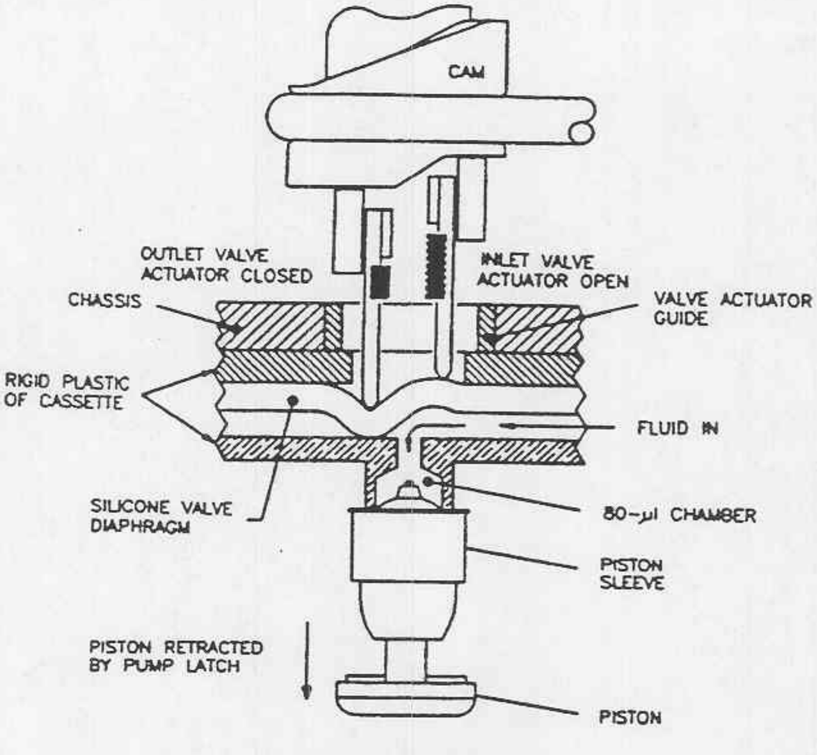


B. POSITION CASSETTE PROPERLY.

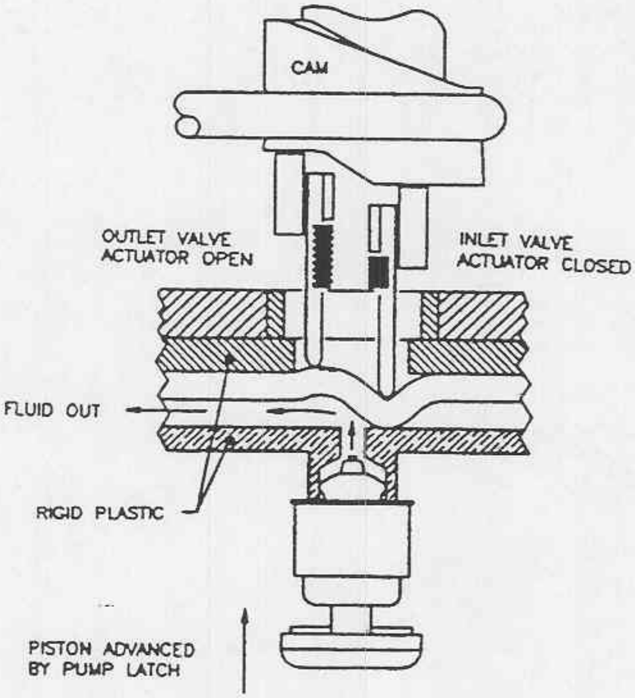


C. CASSETTE ENGAGED.

Figure 2-6. ***Pumping Chamber***


CAM
OUTLET VALVE ACTUATOR CLOSED
INLET VALVE ACTUATOR OPEN
CHASSIS
VALVE ACTUATOR GUIDE
RIGID PLASTIC OF CASSETTE
FLUID IN
SILICONE VALVE DIAPHRAGM
80-μl CHAMBER
PISTON SLEEVE
PISTON RETRACTED BY PUMP LATCH
PISTON

A. FILL STROKE.


CAM
OUTLET VALVE ACTUATOR OPEN
INLET VALVE ACTUATOR CLOSED
FLUID OUT
RIGID PLASTIC
PISTON ADVANCED BY PUMP LATCH

B. DELIVERY STROKE.

2.2 Microprocessor Core

Figures 2-7 and 2-7a are block diagrams of the microprocessor and the components connected to the bus. All components are mounted on the MEA PCBA, unless otherwise noted.

A. Microprocessor

A Z180 8-bit microprocessor system monitors and controls many instrument functions. On-chip functions include a memory management unit, serial communications, two 16-bit programmable reload timers, two direct memory access controllers, and an interrupt controller. In the Model 2860, an on-chip oscillator generates the 6.144 MHz system clock from a 12.288 MHz external crystal. In the Model 2863, an on-chip oscillator generates the 12.288 MHz system clock from a 24.576 MHz external crystal.

B. Address Decoding

The microprocessor bus consists of eight data lines, 20 address lines, and four control lines. In the Model 2860, devices on the microprocessor bus are accessed by the Z180 via logic in the address decode programmable logic device (PLD). This PLD is connected to the address bus and four control lines. In the Model 2863, devices on the microprocessor bus are accessed by the Z180 via logic in the address decode circuits in the two gate arrays. The gate arrays are connected to the address bus and four control lines. In both models, memory and input/output (I/O) maps generate the addresses.

C. Memory

The Z180 can access one megabyte of memory, using the memory management unit. Currently, the instrument uses 256 kilobytes of EPROM for program memory, and 32 kilobytes (Model 2860) or 56 kilobytes (Model 2863) of random access memory (RAM). In the Model 2863, an additional 32 kilobytes of RAM provide dual data paths in hardware to ensure safe operation of software functions. This additional memory is referred to as a shadow RAM. In both models, the EPROMs are mounted on an EPROM board that plugs into the MEA. The RAM is battery-backed to retain information when the instrument is turned off. The integrity of the program and data stored in memory is checked by software which uses a 16-bit cyclical redundancy check (CRC). Corruption of data results in a fault or watchdog alarm.

D. Cyclical Redundancy Check (CRC) (Model 2863 ONLY)

The CRC engines are hardware implementations of an eight-bit parallel CRC-CCITT calculation. The CRC engines are used to detect corruption of system data stored in RAM, to detect errors in messages received over the serial communications link, for the power-on RAM self-test, and to ensure the integrity of the instrument ROM (Read Only Memory) contents. Detecting memory errors (RAM, ROM) result in a watchdog alarm.

E. Input/Output (I/O) Ports

In the Model 2860, three 82C55 integrated circuits (ICs) provide digital input and output lines for interfacing to the microprocessor. Two of the 82C55 ICs are used as output ports, and the third is used as an input port.

In the Model 2863, two gate arrays provide input and output ports for controlling or monitoring digital lines.

F. Real-Time Clock (RTC)

The RTC provides time and date information. This IC is powered by the backup battery when the instrument is turned off.

G. Communications

Serial communication uses the Channel 0 serial port on the microprocessor. An interface IC translates between the microprocessor CMOS levels and RS-232 levels. This interface chip has an on-board charge pump that generates the +10V and -10V required for RS-232 communications. The RS-232 signals are connected to the audio/connector PCBA.

H. Motor Pulse Width Generator

In the Model 2860, pulses for controlling the motors are generated using an 82C54 IC containing three 16-bit programmable counters configured in a one-shot mode.

In the Model 2863, pulses for controlling the motors are generated in Gate Array 1, using three 16-bit programmable counters configured in a one-shot mode. In both models, one independent counter is provided for each pumping channel.

I. Encoder Counters

The encoder provides incremental motion data for determining the volume infused and for controlling motor actuation. In the Model 2860, quadrature encoder output is decoded by a Hewlett-Packard HCTL2000 IC. This integrated circuit includes quadrature decoding and a 12-bit binary up/down counter.

In the Model 2863, Gate Array 1 includes a circuit for quadrature decoding and an 8-bit binary up/down counter to determine the encoder count. There is one circuit for each pumping channel.

J. Analog-to-Digital (A/D) Converter and Multiplexer

Analog signals are sampled by the microprocessor, using an 8-bit A/D converter. This converter contains an eight-channel multiplexer and microprocessor-compatible control logic. A successive approximation method is used by this converter. Conversion time is approximately 100 microseconds. The eight-channel multiplexer is controlled by the microprocessor via the address bus (three bits). In the Model 2860, an external multiplexer circuit provides an additional 32 channels of analog input. In the Model 2863, an external multiplexer circuit provides an additional 24 channels of analog input, for a total of 29 A/D channels.

K. Battery Backup Circuit

When the instrument is turned off, the battery backup circuit maintains the contents of RAM and powers the RTC. Power for battery backup (Vback) is provided by a 2/3 A-size Lithium primary cell. If Vcc falls below 4.6V, a comparator trips, disabling chip-selects to the RAM and RTC, which prevents corruption. An ICL7673 automatic battery-backup switch connects either Vcc or Vback (depending on which voltage is highest) to the RAM and RTC power pin. The output of the ICL7673 is referred to as Vbb.

Figure 2-7. Block Diagram of Microprocessor and Components Connected to the Bus (Model 2860)

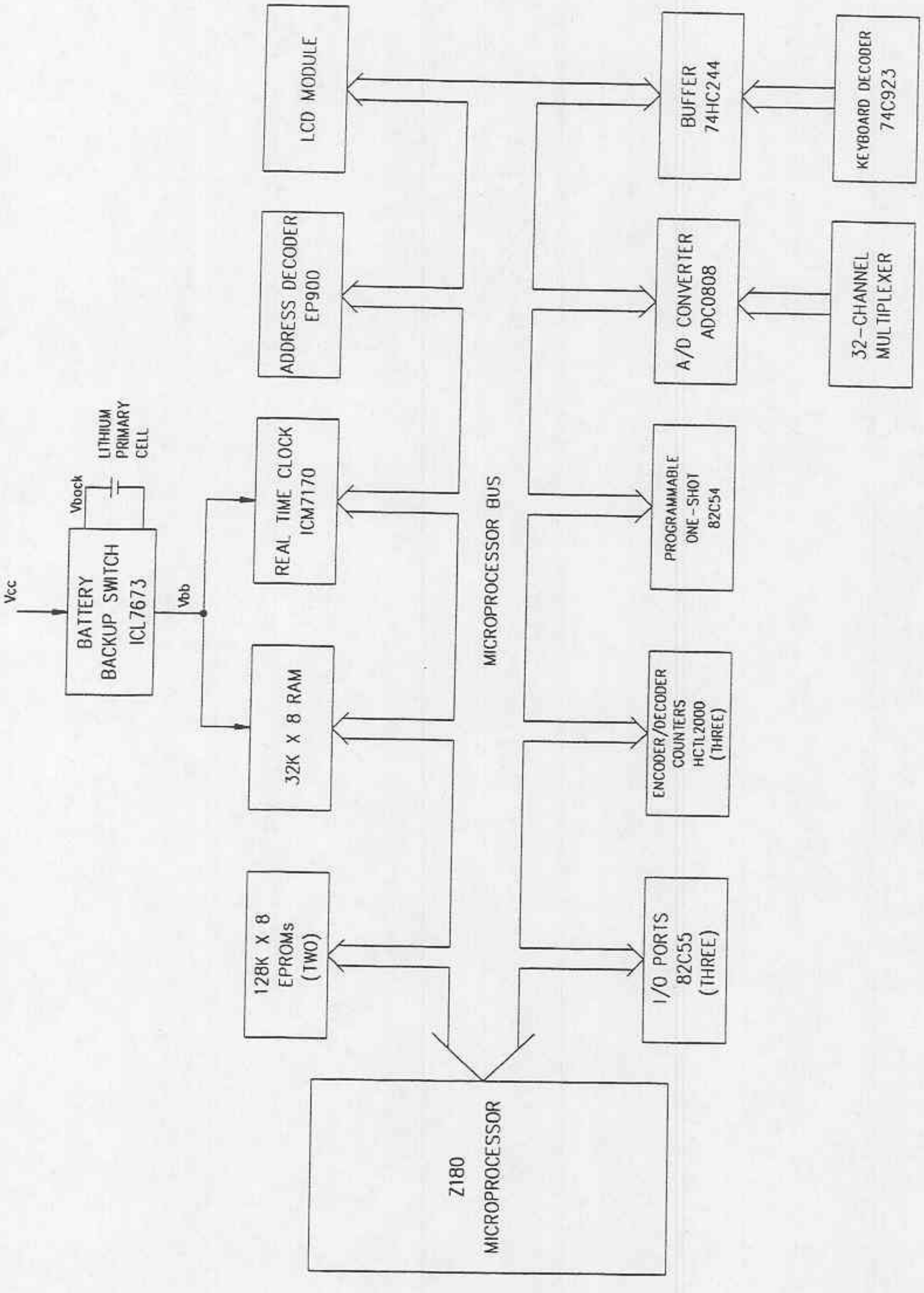
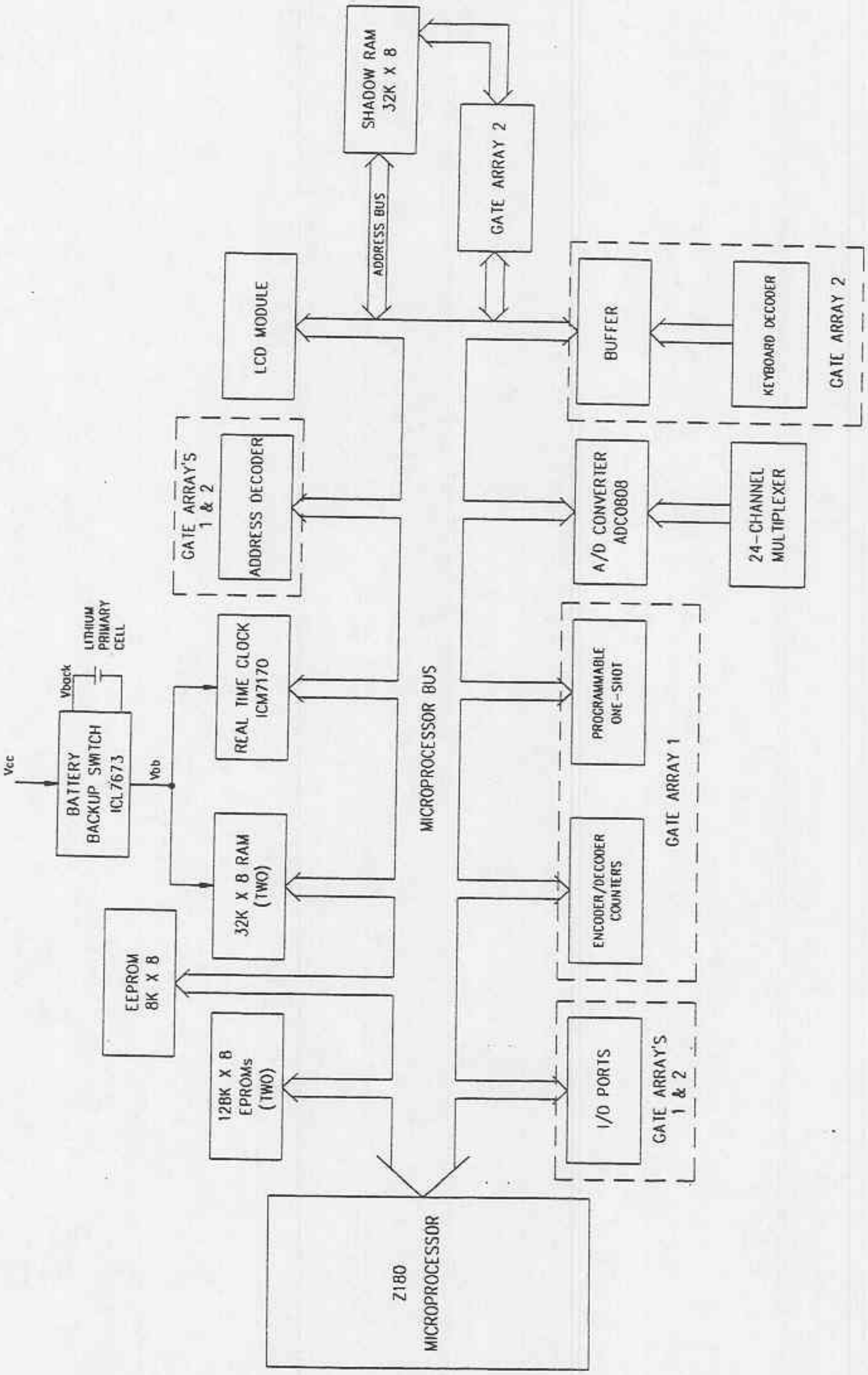

LCD MODULE
BUFFER 74HC244
KEYBOARD DECODER 74C923
ADDRESS DECODER EP900
A/D CONVERTER ADC0808
32-CHANNEL MULTIPLEXER
LITHIUM PRIMARY CELL
Vbock
Vcc
BATTERY BACKUP SWITCH ICL7673
Vbb
REAL TIME CLOCK ICM7170
PROGRAMMABLE ONE-SHOT 82C54
MICROPROCESSOR BUS
32K X 8 RAM
ENCODER/DECODER COUNTERS HCTL2000 (THREE)
128K X 8 EPROMs (TWO)
I/O PORTS 82C55 (THREE)
Z180 MICROPROCESSOR

Figure 2-7a. **Block Diagram of Microprocessor and Components Connected to the Bus (Model 2863)**


SHADOW RAM
32K X 8
GATE ARRAY 2
ADDRESS BUS
LCD MODULE
BUFFER
KEYBOARD DECODER
GATE ARRAY 2
GATE ARRAY'S
1 & 2
ADDRESS DECODER
A/D CONVERTER
ADC0808
24-CHANNEL
MULTIPLEXER
Vcc
BATTERY
BACKUP SWITCH
ICL7673
Vbb
Vback
LITHIUM
PRIMARY
CELL
REAL TIME CLOCK
ICM7170
PROGRAMMABLE
ONE-SHOT
GATE ARRAY 1
MICROPROCESSOR BUS
32K X 8 RAM
(TWO)
ENCODER/DECODER
COUNTERS
EEPROM
8K X 8
128K X 8
EPROMs
(TWO)
I/O PORTS
GATE ARRAY'S
1 & 2
Z180
MICROPROCESSOR

2.3 Watchdog

The watchdog circuit is an independent monitor that ensures safe operation of the microprocessor. The circuit consists of a one-shot, an oscillator/ripple counter, and logic circuitry (see Figures 2-8 and 2-8a).

Figure 2-8. Block Diagram of Watchdog Circuit (Model 2860)

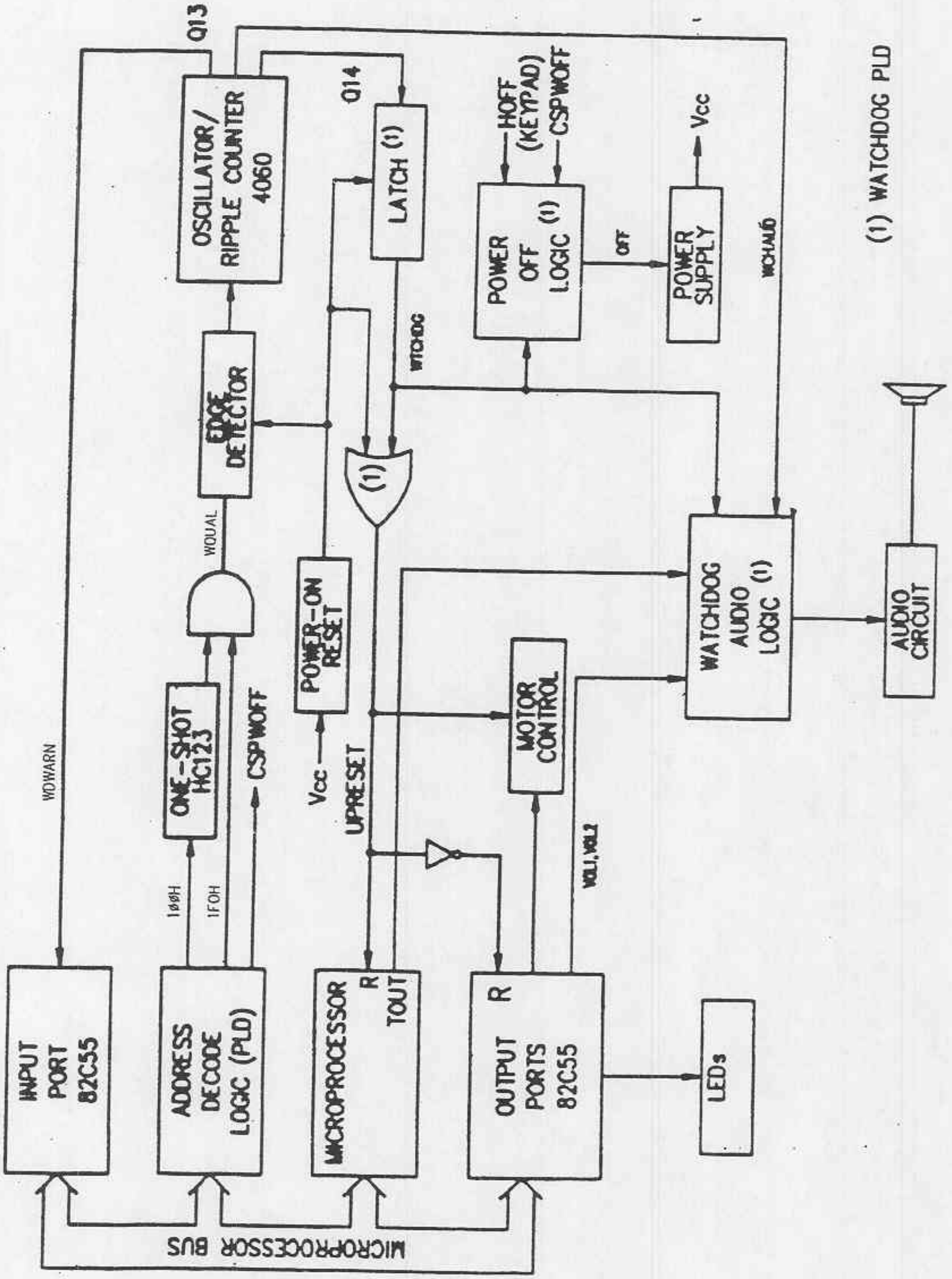
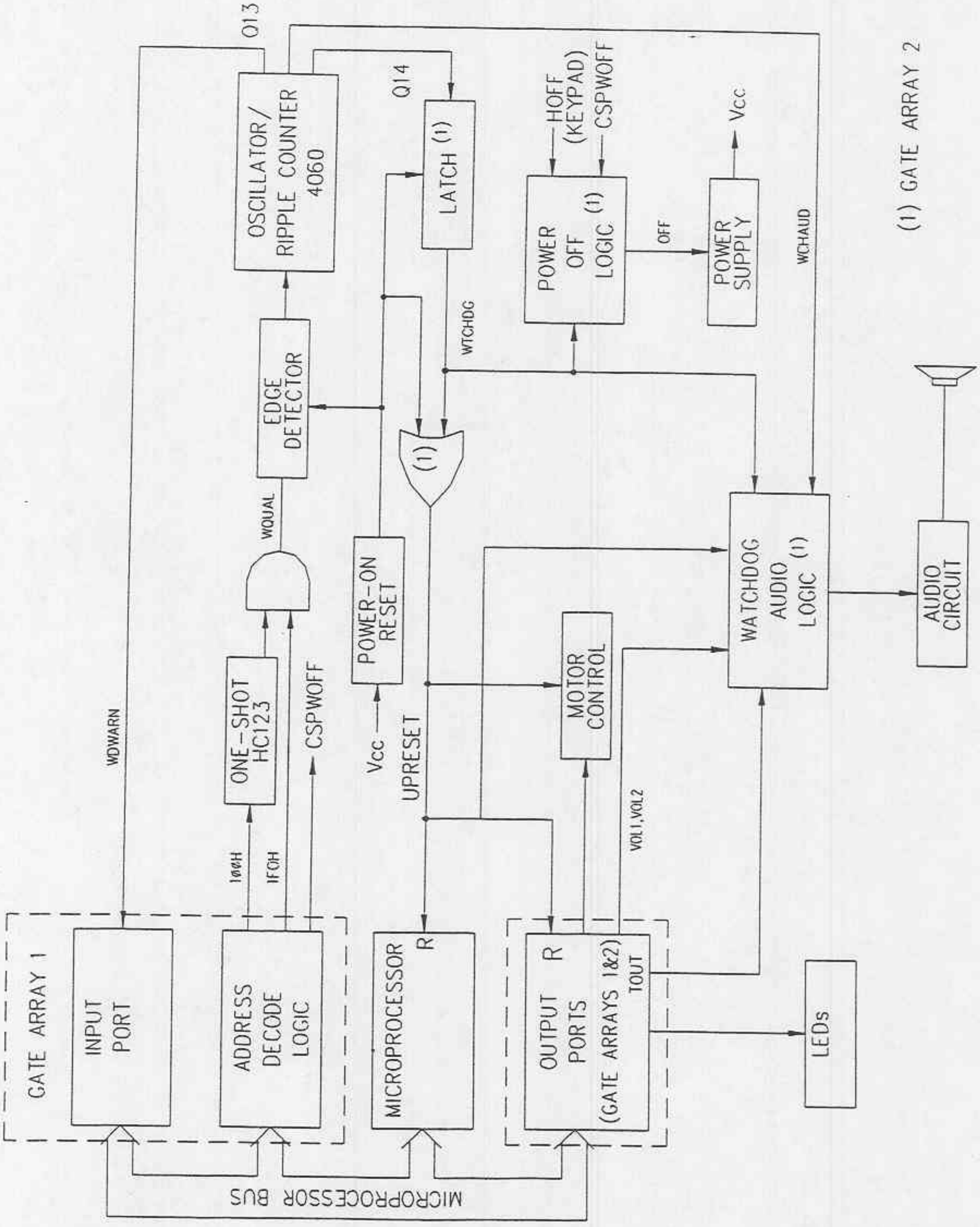

Q13
Q14
OSCILLATOR/ RIPPLE COUNTER 4060
LATCH (1)
HOFF (KEYPAD)
CSPWOFF
Vcc
POWER OFF LOGIC (1)
OFF
POWER SUPPLY
WCHAUD
(1) WATCHDOG PLD
WTCHDG
EDGE DETECTOR
(1)
WOUAL
POWER-ON RESET
WATCHDOG AUDIO LOGIC (1)
AUDIO CIRCUIT
ONE-SHOT HC123
CSPWOFF
Vcc
UPRESET
MOTOR CONTROL
WDWARN
100H
1F0H
VOL1,VOL2
INPUT PORT 82C55
ADDRESS DECODE LOGIC (PLD)
MICROPROCESSOR R TOUT
OUTPUT PORTS 82C55 R
LEDs
MICROPROCESSOR BUS

Figure 2-8a. **Block Diagram of Watchdog Circuit (Model 2863)**


GATE ARRAY 1
INPUT PORT
ADDRESS DECODE LOGIC
MICROPROCESSOR
R
OUTPUT PORTS (GATE ARRAYS 1&2)
R
TOUT
LEDs
MICROPROCESSOR BUS
WDWARN
ONE-SHOT HC123
100H
1F0H
CSPWOFF
Vcc
UPRESET
POWER-ON RESET
VOL1,VOL2
MOTOR CONTROL
WATCHDOG AUDIO LOGIC (1)
AUDIO CIRCUIT
WOUAL
EDGE DETECTOR
OSCILLATOR/ RIPPLE COUNTER 4060
Q13
Q14
LATCH (1)
WTCHDG
(1)
POWER OFF LOGIC (1)
HOFF (KEYPAD)
CSPWOFF
OFF
POWER SUPPLY
Vcc
WCHAUD
(1) GATE ARRAY 2

In the Model 2863, the watchdog circuit is completely tested during power-on. During the watchdog circuit test, the counter is not reset and Q14 will go high, generating a non-maskable interrupt (NMI) to the microprocessor. This shuts off power to the motors and holds the system in reset. Logic in Gate Array 2 allows the watchdog to be reset **once** after the power-on test. After the first reset, if the counter is not periodically reset, the Q14 output will go high again. This will generate a second NMI to the microprocessor, which shuts off power to the motors and holds the system in reset. The watchdog circuit cannot be reset a second time; therefore, the only action possible is to turn off the instrument.

In both models, the power-on reset circuit initializes elements of this system during power-up. If the software fails to reset the counter, a special alarm is triggered. In the Model 2860, logic holds the microprocessor in reset, disables the motors, produces a constant audio tone, and turns on the keypad LEDs. In the Model 2863, logic generates an NMI to the microprocessor and holds the output ports in reset, disables the motors, produces a constant audio tone, and turns on all the keypad LEDs.

The WQUAL signal is generated by the software to reset the counter. Three actions must occur to generate the WQUAL signal. First, the software must detect a high level on the signal WDWARN to ensure the counter is operating at the correct frequency. If this signal is not correct, then either an instrument fault (event code 256) or watchdog alarm occurs. Next, the software writes to I/O address 100H via the address decoding logic, which generates a trigger pulse for the one-shot. The output of the one-shot goes high for 90 microseconds, during which time the software must write to I/O address 1FFH. The combination of these two actions generates the signal WQUAL. The rising edge of the WQUAL signal resets the counter.

Failure to reset the counter circuit results in holding the system in reset. The counter reset input must be pulsed high once every 100 milliseconds (Model 2860) or 200 milliseconds (Model 2863), otherwise, the output line Q14 oscillates. The rising edge of Q14 causes the output of the latch (WTCHDG) to go high, generating the system reset signal and producing a watchdog alarm. In the Model 2860, the UPRESET line holds the output ports (82C55) in reset, blanks the LCD, turns on all six of the keypad LEDs, and shuts off the power to the motors. In the Model 2863, the UPRESET line holds some of the output ports in reset, dims the LCD, turns on all six of the front panel LEDs, and shuts off power to the motors. In both models, the only action that can be performed by the operator is to turn off the instrument.

The power-off logic circuit can power-down the instrument under either normal or watchdog conditions. During normal operation when an ON/OFF keypress is detected, software generates the signal CSPWROFF via the address decoding logic, asserting the OFF signal high. This signal disconnects the 5V and 13V converters on the power supply from the MEA. After the watchdog circuit has triggered, the microprocessor cannot generate the CSPWROFF signal. In this case, the WTCHDG input to the power-off logic is high; and, the HOFF signal from the keypad controls power-down.

During a watchdog alarm, the instrument produces a continuous audio tone. Under normal operation, audio volume and frequency are microprocessor controlled (VOL1, VOL2, and TOUT). When the watchdog circuit triggers, logic circuits in the watchdog PLD (Model 2860) or in Gate Array 2 (Model 2863) produce a continuous audio tone at the highest volume. The watchdog tone WCHAUD signal is generated by the ripple counter.

2.4 User Interface

A. Keypad Circuit

The keypad circuit provides controls for operating the instrument. The keypad control switches consist of a separate ON/OFF key and a matrix of 10 function keys. When a key is pressed, the interface circuit generates an interrupt (KBDINT*) to the microprocessor which then reads an input port to determine whether a function key or the ON/OFF key was pressed (see Figures 2-9 and 2-9a). The interrupts are cleared by the microprocessor through output port KBDINTCLR.

The ON/OFF key is separate from the function key matrix. Debouncing is performed by a resistor capacitor (RC) time constant and Schmitt trigger. An interrupt is generated from the debounced signal, HOFF, by latching the output of an edge detector. The HOFF also goes to the watchdog power-off logic and an input port.

The function key switch matrix is connected to a 74C923 keyboard decoder in the Model 2860, and a keyboard decoder in Gate Array 2 in the Model 2863 which debounces key presses, decodes the key matrix, and informs the microprocessor of a keypress. During a keypress, the KBDDA line goes high for the duration of the keypress. Interrupts are generated from the leading and trailing edges of KBDDA. The KBDDA is sampled via an input port to determine whether the key is depressed or released. The location of the keypress in the matrix is communicated from the decoder to the microprocessor, using five (Model 2860) or four (Model 2863) bits of the data bus.

A foil layer in the keypad provides shielding against electrostatic discharges. A tab from the shield is attached to the conductive coating on the inside of the main housing, using conductive tape.

B. Liquid Crystal Display (LCD)

A "super-twist" transflective LCD is mounted on a separate PCBA known as the Display Module. The Display Module includes display drivers, a display controller, and the necessary RAM to control the LCD. The LCD communicates to the microprocessor via the bus. The LCD requires a negative voltage (-Vlcd) to change the orientation of the liquid crystals. This voltage is supplied by the contrast control circuit. The LCD is backlit by an electroluminescent (EL) panel driven from an AC supply on the power supply PCBA.

C. Liquid Crystal Display Contrast

The LCD contrast is adjusted by varying the negative supply voltage, Vlcd. A block diagram of this circuit is shown in Figure 2-10. An ICL7660 generates a -5V power source which is converted to Vlcd by the SCI7661. A low level on the output port LCD ON*/OFF turns on the ICL7660. The output of the SCI7661 is connected to a resistor string.

Different string outputs are connected by a multiplexer to the feedback pin of the SCI7661. This circuit provides regulated negative supply voltage in the range of -11V to -14V. The resistor string tap is selected by software through the use of the VIEW (Model 2860) or CNTRST (Model 2863) softkey, using three output ports (LCDCTRST1, LCDCTRST2, and LCDCTRST3). Seven contrast levels are provided by the three control lines.

D. Infuse and Alarm LEDs

The infuse (green) and alarm (red) LEDs that appear in the upper corners of the Channel Select keys (A, B, and C) are controlled by software, using output ports. In both models, the LED is turned on if an output port is set high. Self-tests of the LEDs are performed by using the A/D converter to measure the voltage drop across the LED.

Figure 2-9. ***Block Diagram of Keypad Circuit (Model 2860)***

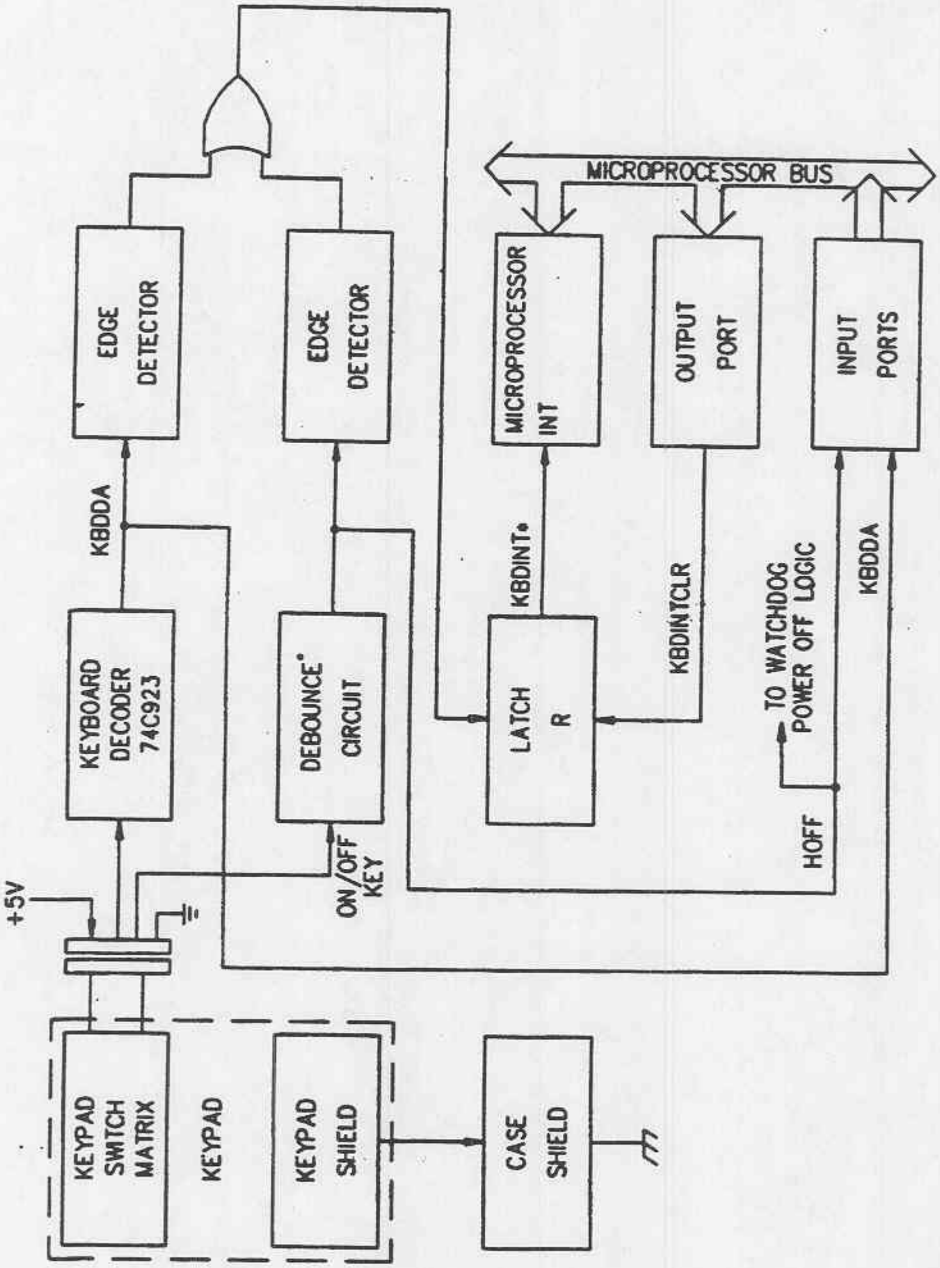

MICROPROCESSOR BUS
EDGE DETECTOR
EDGE DETECTOR
MICROPROCESSOR INT
OUTPUT PORT
INPUT PORTS
KBDDA
KBDINT*
KBDINTCLR
TO WATCHDOG POWER OFF LOGIC
KBDDA
KEYBOARD DECODER 74C923
DEBOUNCE* CIRCUIT
LATCH R
HOFF
+5V
ON/OFF KEY
KEYPAD SWITCH MATRIX
KEYPAD
KEYPAD SHIELD
CASE SHIELD

Figure 2-9a. Block Diagram of Keypad Circuit (Model 2863)

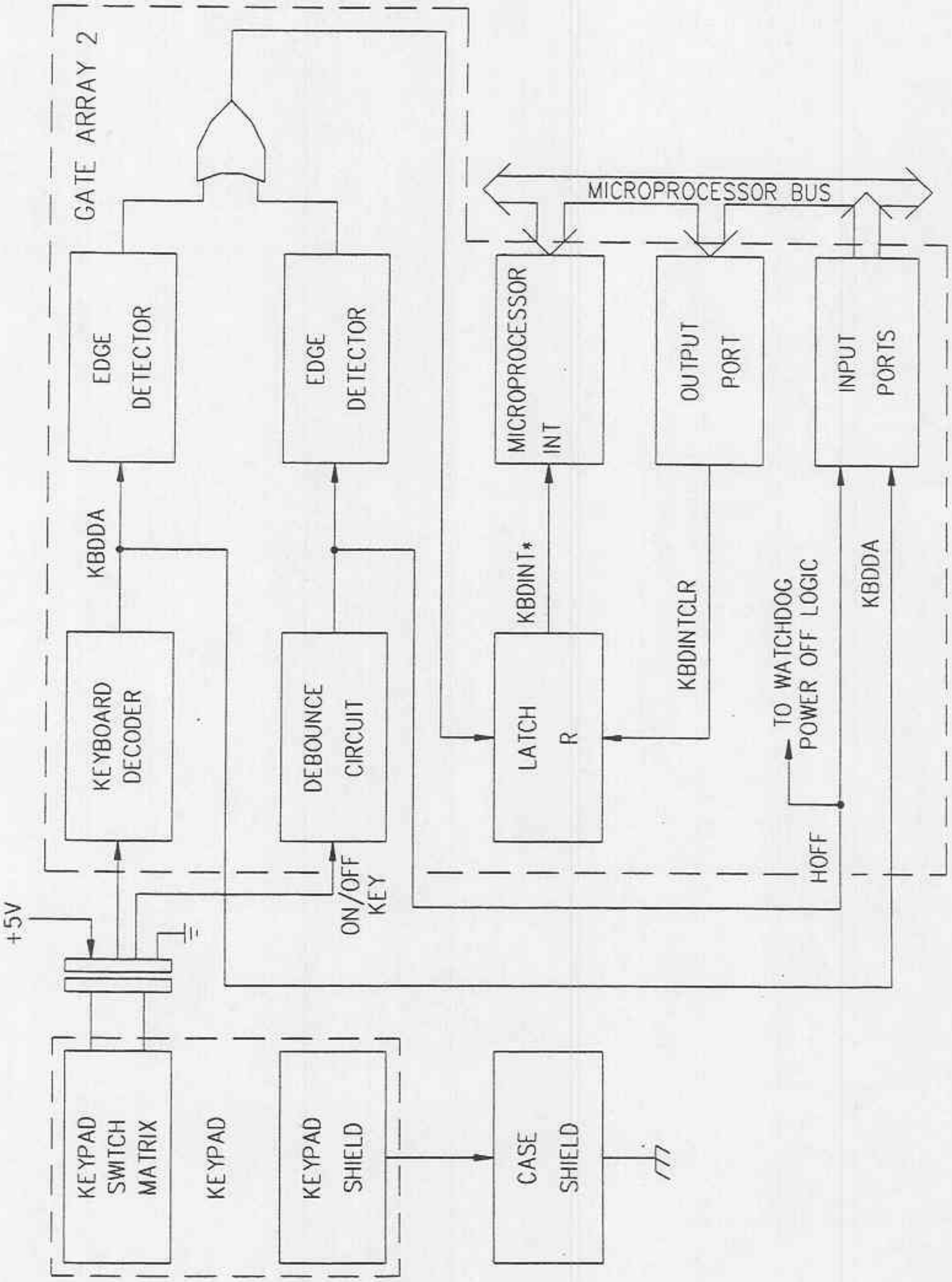
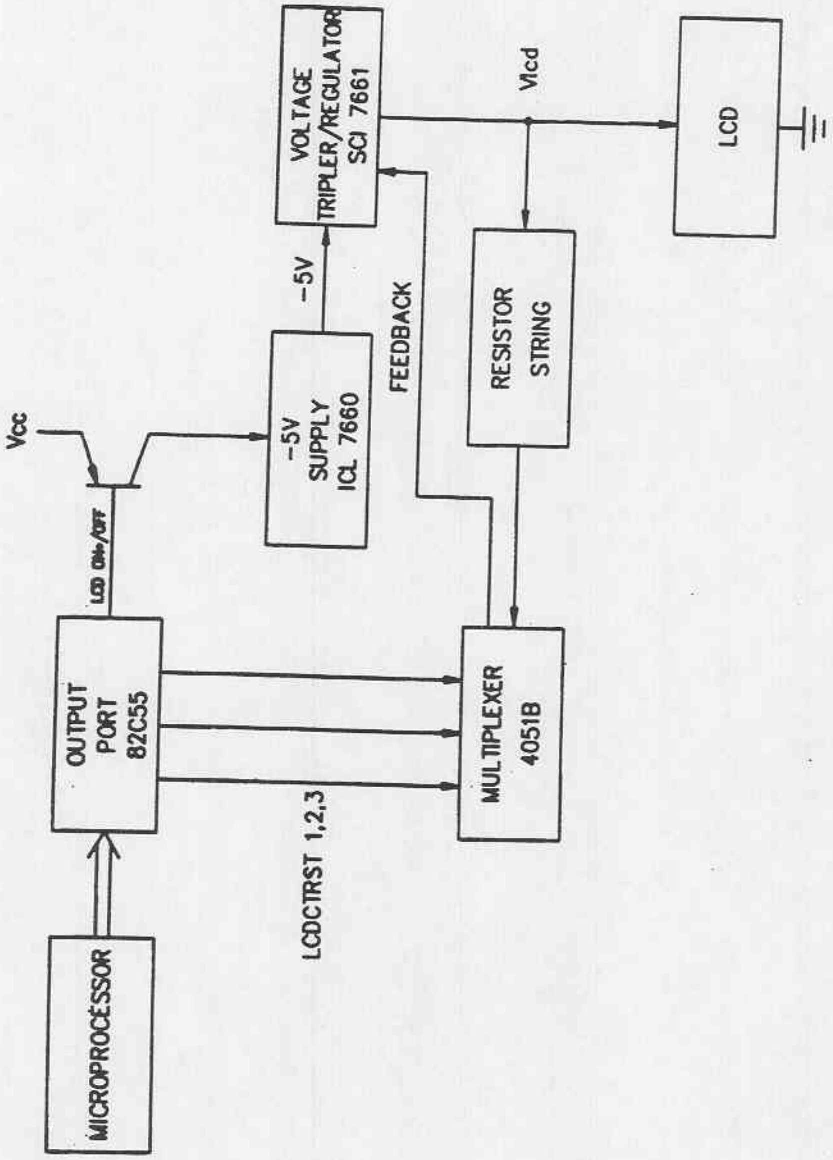

GATE ARRAY 2
EDGE DETECTOR
EDGE DETECTOR
MICROPROCESSOR BUS
MICROPROCESSOR INT
OUTPUT PORT
INPUT PORTS
KBDDA
KEYBOARD DECODER
DEBOUNCE CIRCUIT
KBDINT*
LATCH
R
KBDINTCLR
TO WATCHDOG POWER OFF LOGIC
KBDDA
HOFF
ON/OFF KEY
+5V
KEYPAD SWITCH MATRIX
KEYPAD
KEYPAD SHIELD
CASE SHIELD

Figure 2-10. Block Diagram of LCD Contrast Control Supply Voltage Circuitry


VOLTAGE TRIPLER/REGULATOR SCI 7661
Vlcd
LCD
-5V
FEEDBACK
RESISTOR STRING
Vcc
-5V SUPPLY ICL 7660
LCD ON/OFF
OUTPUT PORT 82C55
MULTIPLEXER 4051B
LCDCTRST 1,2,3
MICROPROCESSOR

E. Audio

Audio output is generated by a speaker on the audio/connector PCBA via the circuit shown in Figures 2-11 and 2-11a. The volume levels are controlled by the microprocessor, using output ports VOL1 and VOL2. The audio tones are generated using a programmable reload timer in the microprocessor (Model 2860) or in Gate Array 1 (Model 2863). Software generates different frequencies by loading a count into the timer control registers. The timer output, TOUT, is connected to the watchdog audio logic in the watchdog PLD (Model 2860) or in Gate Array 2 (Model 2863). Different amplitude drive signals provide volume control. The drive signal amplitude is determined by a multiplexer which selects a resistor string tap. This, in turn, applies different levels of DC voltage to the speaker drive transistor.

Figure 2-11. *Block Diagram of Audio Generator Circuit (Model 2860)*

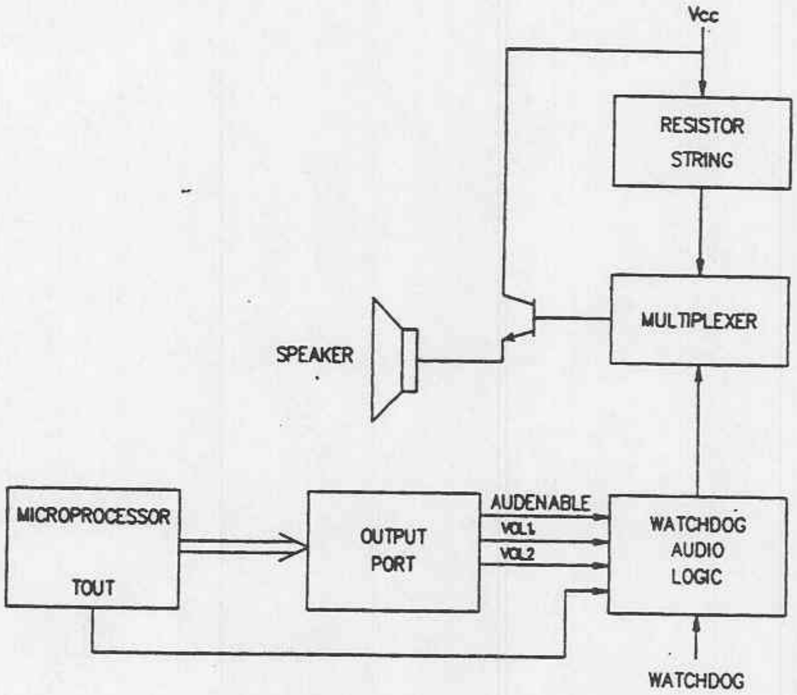
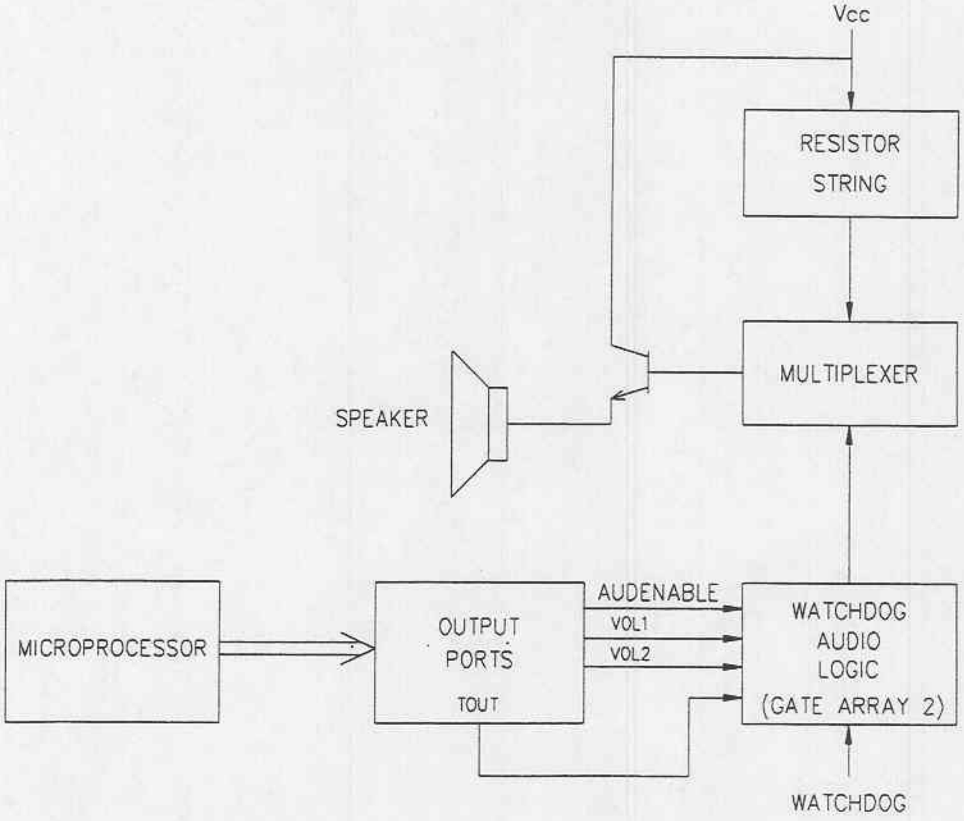

Vcc
RESISTOR STRING
MULTIPLEXER
SPEAKER
MICROPROCESSOR
TOUT
OUTPUT PORT
AUDENABLE
VOL1
VOL2
WATCHDOG AUDIO LOGIC
WATCHDOG

Figure 2-11a. *Block Diagram of Audio Generator Circuit (Model 2863)*


Vcc
RESISTOR STRING
MULTIPLEXER
SPEAKER
MICROPROCESSOR
OUTPUT PORTS
TOUT
AUDENABLE
VOL1
VOL2
WATCHDOG AUDIO LOGIC (GATE ARRAY 2)
WATCHDOG

2.5 Motor Control System

A. System Overview

Infusion rate is regulated using a feedback system to control the motor (see Figures 2-12 and 2-12a). The encoder provides one signal (DEL) that indicates the pumping cycle (e.g., delivery) and two signals (A and B) to determine incremental motion. The A and B signals are derived from a single LED source and a pair of phototransistors that are physically offset. This provides for a higher encoder resolution than is obtainable with a single phototransistor. Since the phototransistors are offset, the resultant waveforms for the A and B tracks are 90 degrees out of phase (see Figure 2-13). This allows for quadrature decoding, a method for determining direction of motion by comparing two out-of-phase signals. The A and B signals are decoded and counted using an HCTL2000 IC in the Model 2860, or by circuits in gate array 1 in the Model 2863; both are connected to the microprocessor bus. Every three seconds, a feedback control algorithm in software determines the appropriate motor pulse width from the difference between the required and the measured number of encoder counts. The calculated pulse width is loaded into an 82C54 programmable interval timer in the Model 2860, or into a programmable one-shot circuit in Gate Array 1 in the Model 2863. In the Model 2860, logic circuits in the motor control PLD control the action of the drive circuits. In the Model 2863, the logic circuits in Gate Array 1 control the action of the drive circuits. In both models, the drive circuits also include redundant shutoff transistors to prevent faults from causing motor run-away. A drive voltage of 5V is used for rates of 275 ml/h or less, and 13V is used for rates greater than 275 ml/h.

B. Encoder

The encoder mounted on the cam shaft provides three signals (DEL, A, and B) for controlling the motors. The following are determined from these three signals: (1) home position, (2) DEL marker, indicating the pump delivery stroke, (3) 160 incremental counts during DEL, and (4) a brake marker at the end of refilling. The home position, which is at the beginning of the fill stroke, is used to locate the drive for ease of cassette installation and for the fluid-side occlusion detection. Homing is only performed when a cassette is not present (refer to Operating Instructions for details). The DEL marker and incremental counts are used to control fluid delivery. At low infusion rates, the brake marker stops the mechanism near the beginning of the delivery stroke.

The shaft encoder consists of a PCBA permanently mounted on the drive module housing and a slotted disk mounted to the cam shaft. The PCBA includes an LED light source, slit plates, three phototransistor detectors, and three amplifiers. The slotted disc is located between the slit plates which collimate light rays to the desired detector (see Figure 2-14).

Since the encoder LED requires approximately 20 milliamps to operate, it is strobed by logic in a PLD (Model 2860) or in Gate Array 1 (Model 2863) to save power. A current regulator circuit is in series with the LED to minimize Vcc and temperature variations. With the LED on, light shining through an opening on the slotted disc causes the phototransistors to conduct. The output of the phototransistors is buffered and latched. The latches are on the MEA. Hysteresis is provided on the DEL signal to prevent signal jitter, in the event that the encoder disc stops on the edge of the DEL track.

The nominal timing of the latched encoder signals is shown in Figure 2-13. The first rising edge of the A signal produced by the first quadrature slot is defined as zero degrees or top dead center (TDC). This edge is aligned very accurately to the cam such that it signals the beginning of a pump stroke. The rising edge of DEL marker occurs about 12 degrees before TDC and is used as a brake marker. The falling edge of DEL occurs nominally coincident with the falling edge of the last slot of the B signal. The home marker is the logical combination of A and the complement of DEL (DEL*) implemented in the motor control logic PLD in the Model 2860, or in Gate Array 1 in the Model 2863.

> ***WARNING***
>
> *The alignment of the cam to the encoder is critical for proper fluid delivery; therefore, do not repair defective modules. Defective modules must be replaced.*

Encoder self-test is performed by software. The DEL marker is polled every 50 milliseconds via an I/O port. The software ensures that the encoder counts properly while pumping. If an abnormal condition is detected, a channel fault alarm occurs.

C. Pulse Width Generation

In the Model 2860, the motor pulse width generated by the feedback control algorithm is implemented using an 82C54 programmable interval timer that is operated in a hardware-triggered, programmable, one-shot mode. When a pulse width count is loaded from the microprocessor, the output goes high, and the timer decrements during the DEL cycle. When the counter decrements to zero, the output goes low. This turns off the motor. The counter is not decremented during the DEL* filling cycle. This is accomplished by gating the clock input with the DEL signal, using logic in the motor control PLD (Model 2860) or in the motor control circuits of Gate Array 1 (Model 2863).

In the Model 2863, the motor pulse width generated by the feedback control algorithm is implemented using a programmable one-shot. When a pulse width count is loaded from the microprocessor, the output goes low, and the timer decrements during the DEL cycle. When the counter decrements to zero, the output goes high. This turns off the motor. The counter is not decremented during the DEL* filling cycle. This is accomplished by gating the one-shot clock input with the DEL signal, using logic in the motor control circuits of Gate Array 1.

D. Motor Control Logic

Logic incorporated in a PLD (Model 2860) or in Gate Array 1 (Model 2863) is used to control the motor drive circuitry. The inputs to the control logic are the 82C54 pulse width generator (Model 2860) or the programmable one-shot pulse width generator (Model 2863), the encoder DEL and A track signals, and several output port control lines (Figures 2-12 and 2-12a). This logic performs several functions which include controlling the motor drive voltage, decrementing the counter to generate the motor pulse width, turning on the brake transistor, and homing the mechanism.

E. Motor Drive Circuitry

The motor drive circuits (Figures 2-15 and 2-15a) control the application of power to the motor. During an infusion, the pulse width, modified by the motor control logic, is applied to the gates of FETs connected to the motor. One FET is used to apply 5V of power to the motors for low infusion rates, and a second FET applies 13V to the motors for high rates. A level shifter converts the motor control logic signal to a voltage required to control the 13V FET. Whenever the motor is not being operated, it is shorted by the brake FET.

Figure 2-12. Block Diagram of Motor Control System (Model 2860)

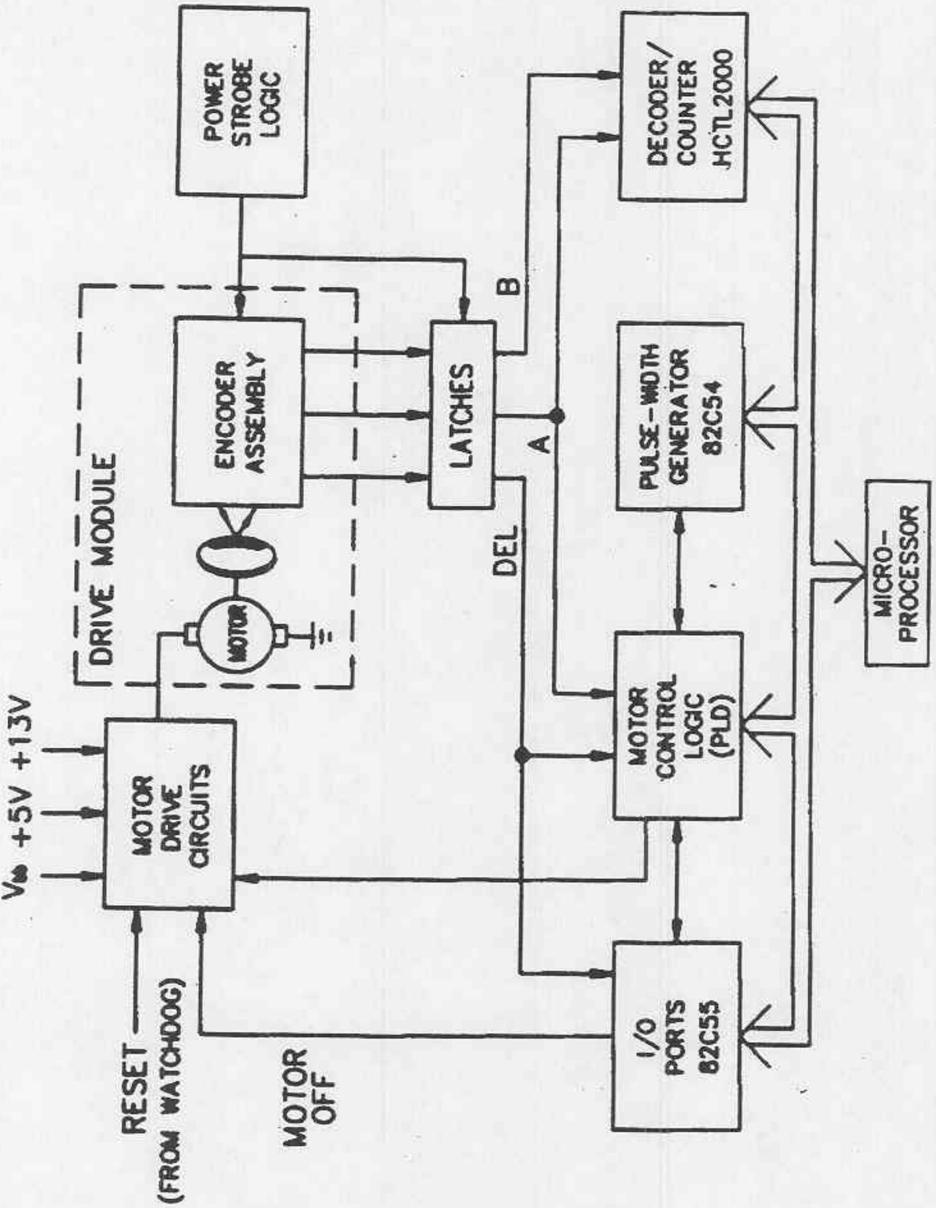

POWER STROBE LOGIC
DECODER/ COUNTER HCTL2000
B
DRIVE MODULE
ENCODER ASSEMBLY
LATCHES
A
PULSE-WIDTH GENERATOR 82C54
DEL
MICRO-PROCESSOR
MOTOR
V
+5V
+13V
MOTOR DRIVE CIRCUITS
MOTOR CONTROL LOGIC (PLD)
I/O PORTS 82C55
RESET (FROM WATCHDOG)
MOTOR OFF

Figure 2-12a. Block Diagram of Motor Control System (Model 2863)

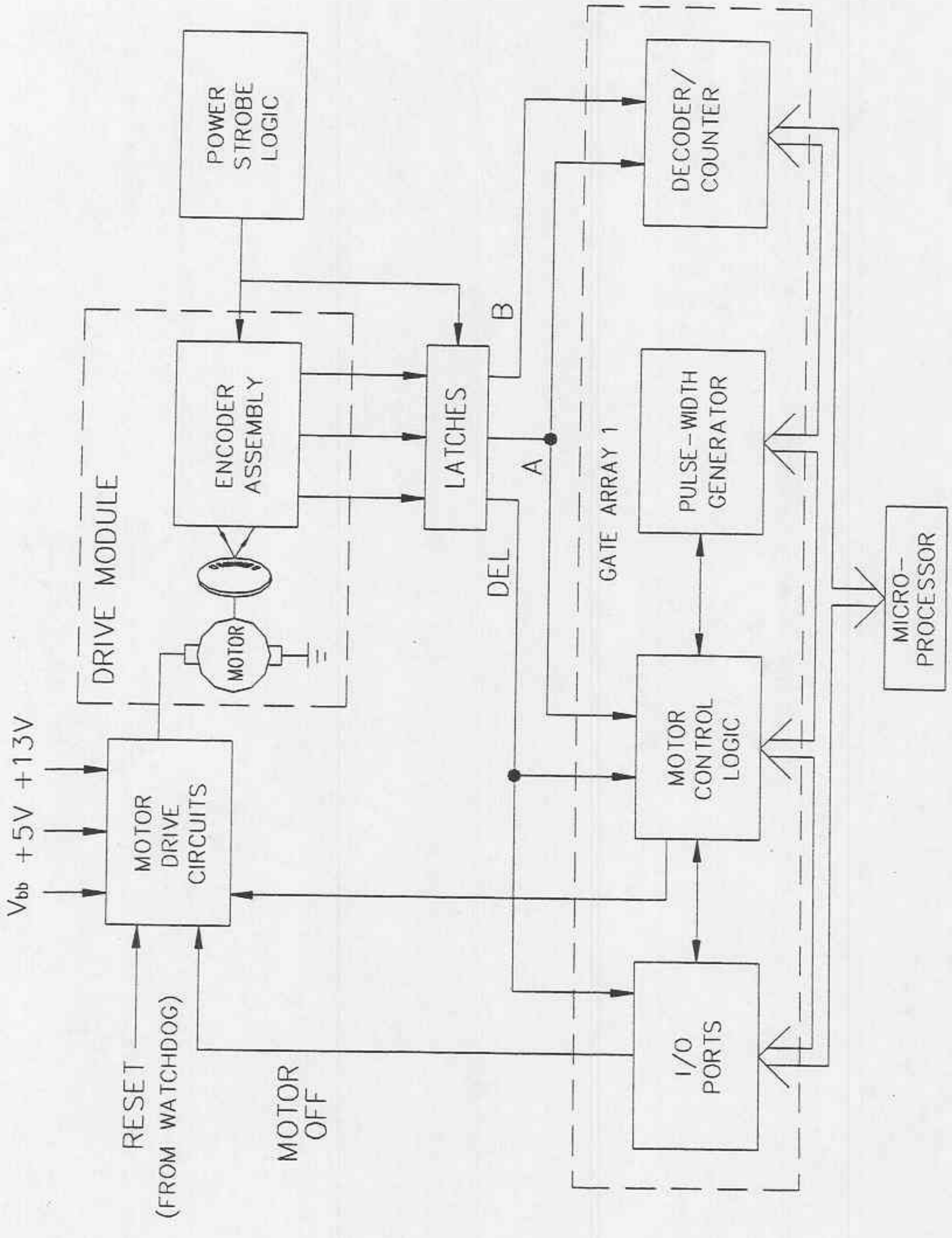

POWER STROBE LOGIC
DRIVE MODULE
ENCODER ASSEMBLY
MOTOR
LATCHES
B
A
DEL
GATE ARRAY 1
DECODER/ COUNTER
PULSE-WIDTH GENERATOR
MOTOR CONTROL LOGIC
I/O PORTS
MICRO-PROCESSOR
Vbb +5V +13V
MOTOR DRIVE CIRCUITS
RESET (FROM WATCHDOG)
MOTOR OFF

Figure 2-13. **Nominal Timing of Latched Encoder Signals**

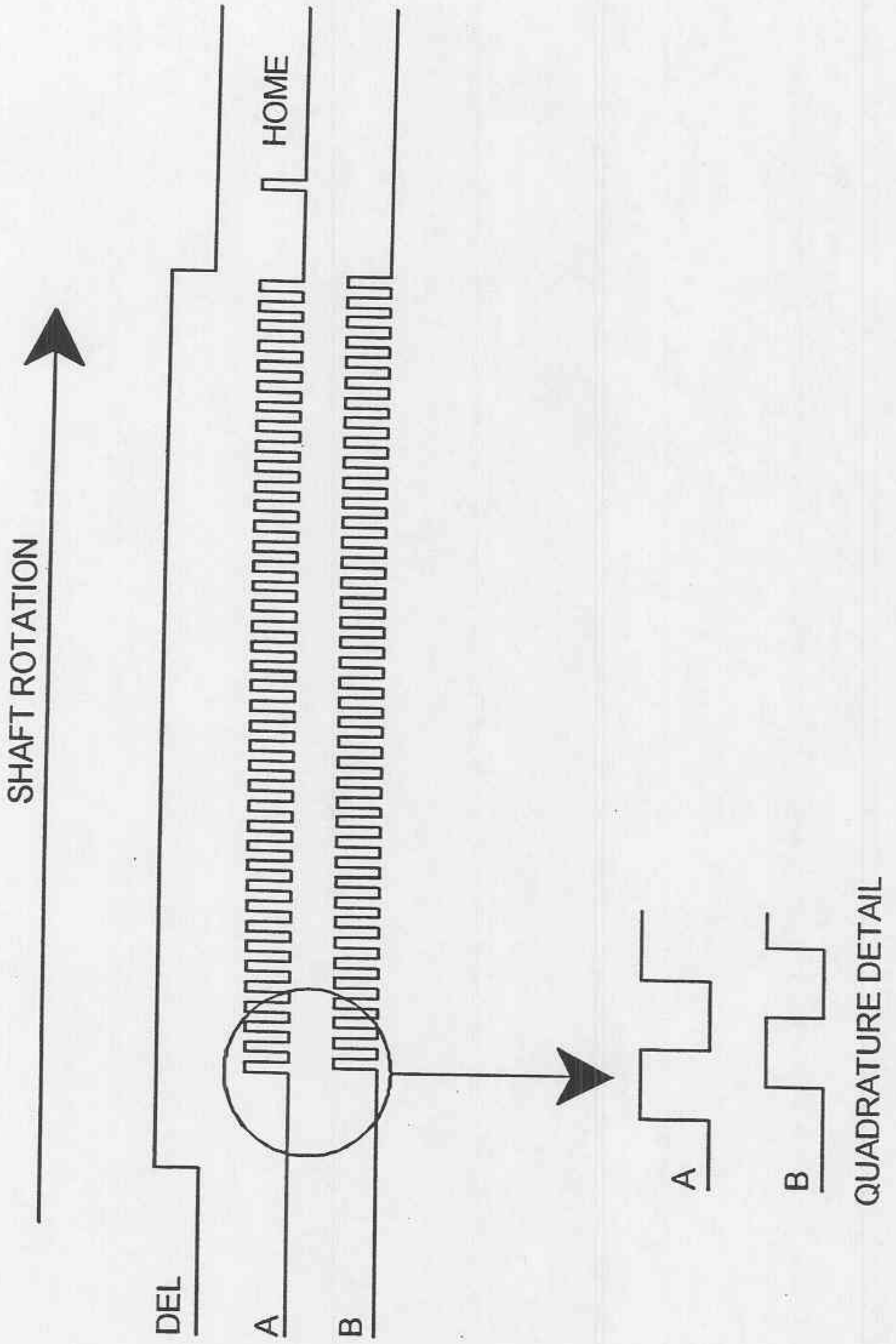

SHAFT ROTATION
HOME
DEL
A
B
A
B
QUADRATURE DETAIL

Figure 2-14. **Encoder Interface PCBA**

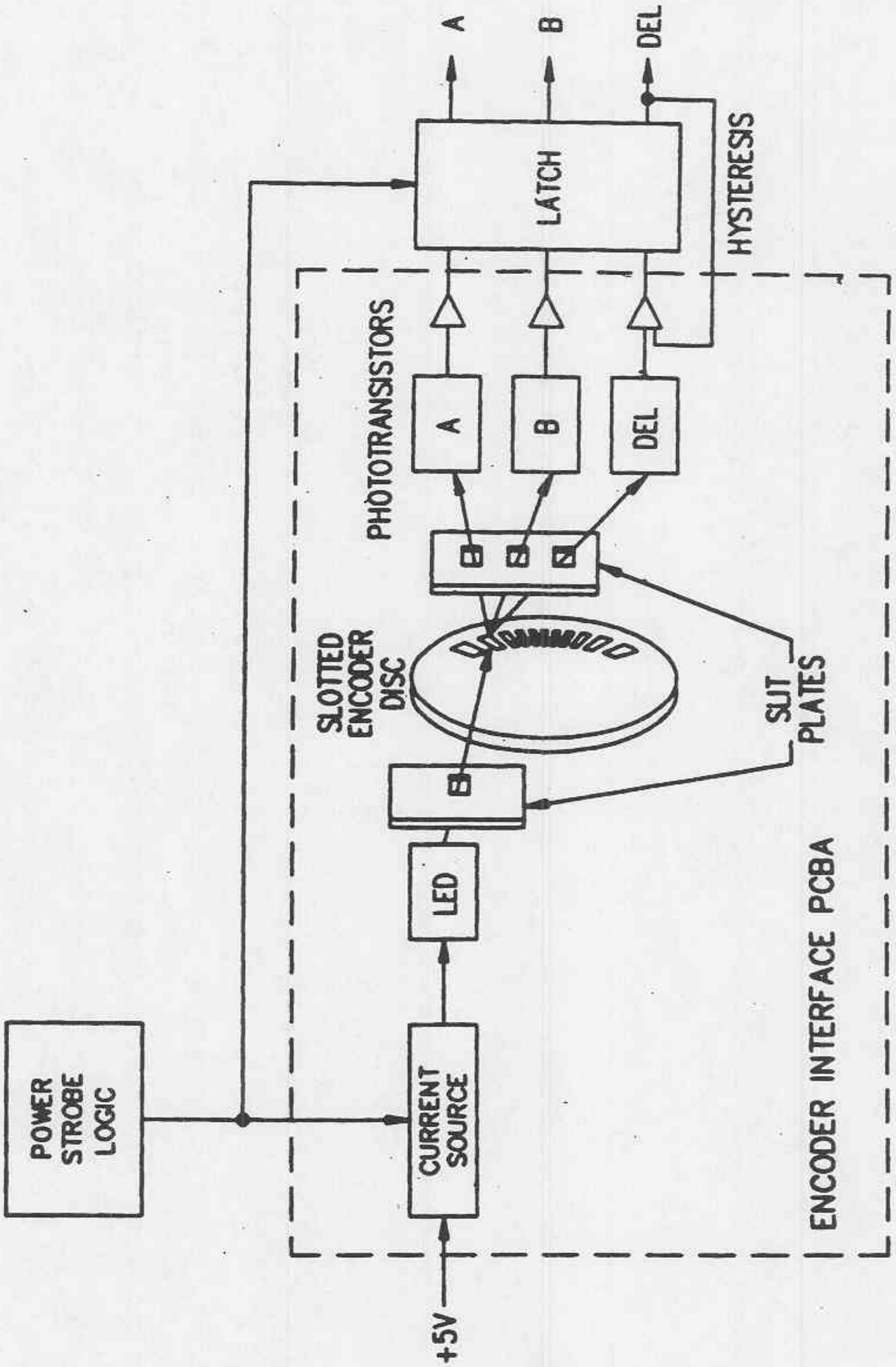

POWER STROBE LOGIC
+5V
CURRENT SOURCE
LED
SLOTTED ENCODER DISC
SLIT PLATES
PHOTOTRANSISTORS
A
B
DEL
LATCH
HYSTERESIS
A
B
DEL
ENCODER INTERFACE PCBA

Figure 2-15. Block Diagram of Motor Drive Circuit (Model 2860)

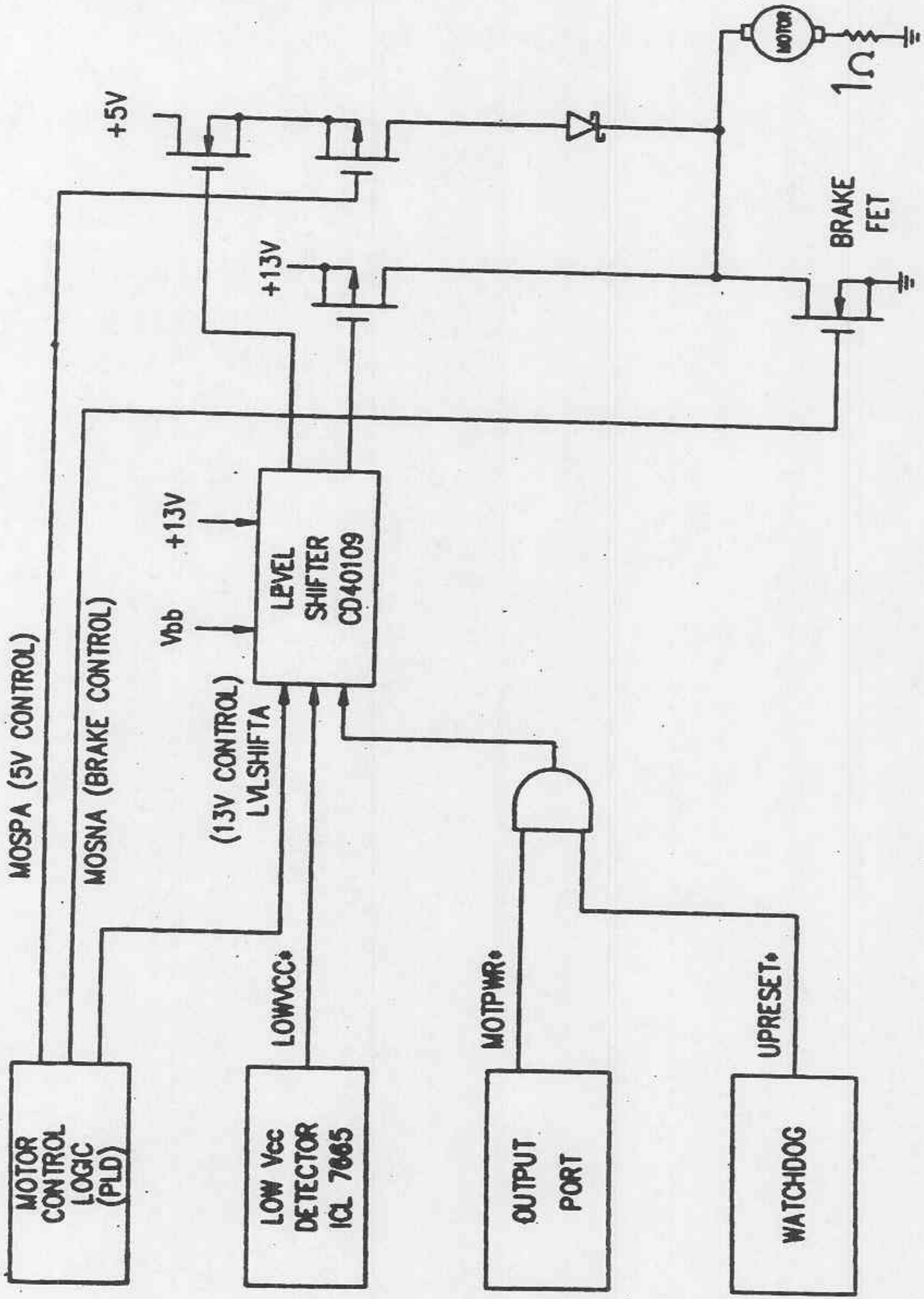
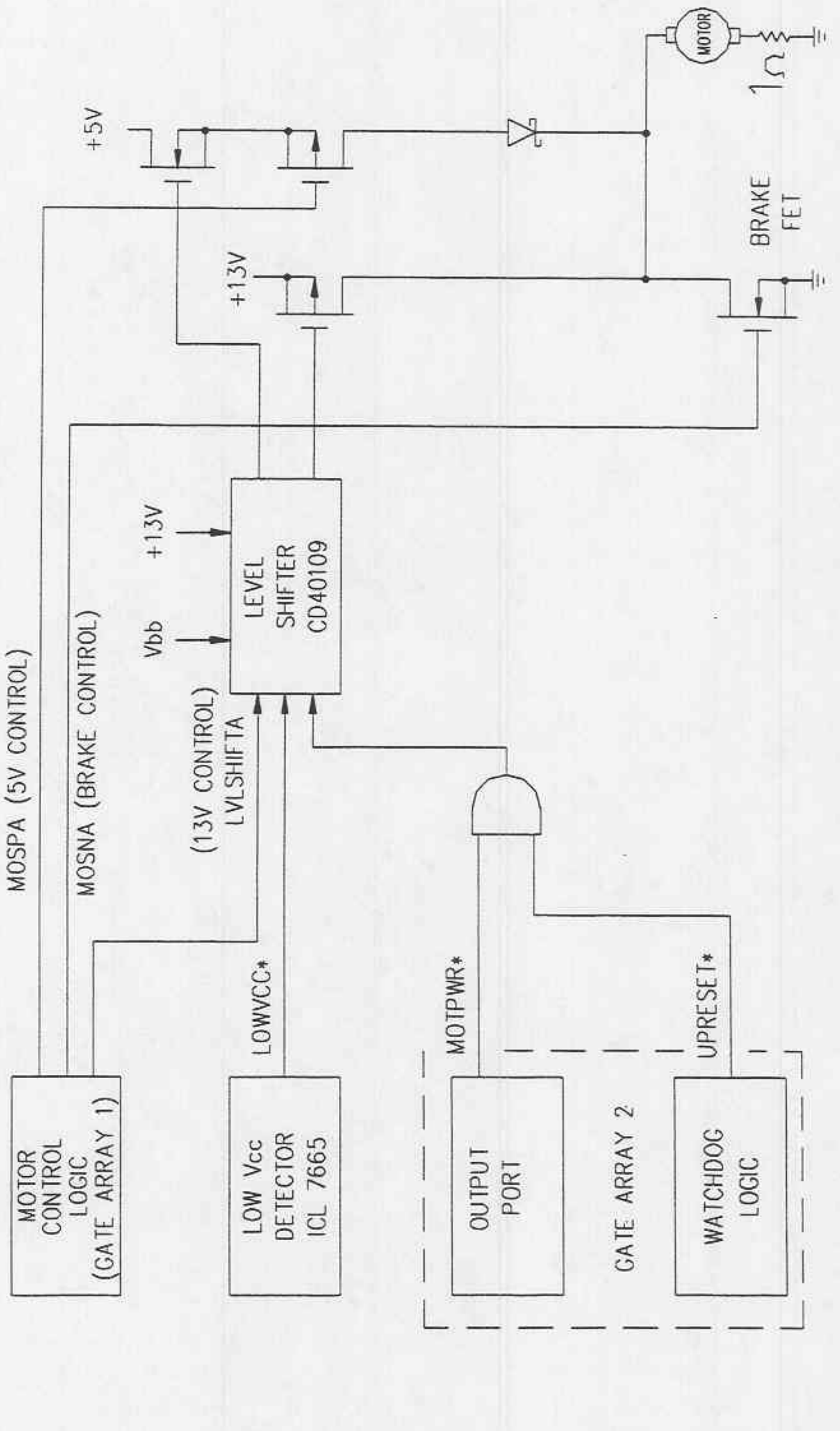

MOTOR
1Ω
+5V
BRAKE FET
+13V
+13V
Vbb
LEVEL SHIFTER CD40109
MOSPA (5V CONTROL)
MOSNA (BRAKE CONTROL)
(13V CONTROL) LVLSHIFTA
LOWVCC*
MOTPWR*
UPRESET*
MOTOR CONTROL LOGIC (PLD)
LOW Vcc DETECTOR ICL 7665
OUTPUT PORT
WATCHDOG

Figure 2-15a. **Block Diagram of Motor Drive Circuit (Model 2863)**


MOTOR
1Ω
+5V
BRAKE FET
+13V
+13V
Vbb
LEVEL SHIFTER CD40109
MOSPA (5V CONTROL)
MOSNA (BRAKE CONTROL)
(13V CONTROL) LVLSHIFTA
LOWVCC*
MOTPWR*
UPRESET*
MOTOR CONTROL LOGIC (GATE ARRAY 1)
LOW Vcc DETECTOR ICL 7665
OUTPUT PORT
GATE ARRAY 2
WATCHDOG LOGIC

2.6 Infusion Monitoring

A. Cassette and Latch Sensing

Before an infusion can be started, a cassette must be installed and the pump latch closed. An alarm occurs if the cassette is removed during an infusion. The optomodule is located between the chassis and air-in-line sensor module. Cassette placement and pump latch position are sensed by the optomodule which includes four infrared LED-phototransistor pairs. Cassette placement is sensed by three transmissive pairs (see Figures 2-16 and 2-16a). When the cassette is installed, the cassette I.D. optics modify the path of the light beam. Cassette I.D. optics can either be light pipes or a prism that deflects the light beam. This provides a 3-bit code that can be read by the microprocessor. Future applications may use these codes to detect different cassette types. The pump latch position is sensed by the fourth LED photo-transistor pair, operating in a reflective mode. The slide link, which engages the pump latch and the cassette slide clamp, has a hot-stamped foil reflector. When the latch is closed, the reflector is located over the sensor, resulting in a logical high output.

The cassette and latch sensing circuit are controlled by software to minimize power consumption. Five output ports enable the LED-phototransistor pairs. Two of the output ports are control lines for turning on the LEDs. Three control lines are used to select which phototransistor output is connected to the A/D converter. Software then compares the sampled values with calibration constants stored in memory to determine cassette and latch states. Calibration compensates for variations in the current transfer ratio of the LED and phototransistor pairs.

B. Air-in-line Detection

Ultrasonic transduction methods are used to detect air in the tubing as it exits the cassette. The tubing is placed between an ultrasonic transmitter and a receiver crystal, which are mounted inside the tubing recess of the air-in-line sensor module. Fluids readily propagate high-frequency ultrasonic energy, while air is a very poor conductor. The output of the receiver is converted to a digital signal for software interpretation of the air bubble volume.

A block diagram of the air-in-line detection system is shown in Figures 2-17 and 2-17a. A voltage-controlled oscillator (VCO) provides the excitation for the transmitter piezoelectric crystal. The VCO sweeps through a range of frequencies to ensure that the resonant peak of the crystal is excited. Strobe logic operates the VCO intermittently to reduce power consumption. The output of the receiver is converted to a digital pulse by a comparator when a sufficiently large signal is detected. Fluid in the tubing results in a series of comparator output pulses due to the intermittent operation of the VCO. Air in the tubing results in no output pulses. The comparator output pulses trigger a one-shot which converts the pulsed or nonpulsed input into a high (fluid) or low (air) level output which is then latched in a PLD on the MEA.

The volume of air and fluid present at the detector is determined by the microprocessor. The sensor output latch for each channel is connected to an input port. An interrupt is generated by the edge of an air bubble. The software responds to the interrupt by reading the sensor input ports for all three channels (A,B, and C). An algorithm determines which channel caused the interrupt and whether fluid or air is present. The interrupt latch is then cleared. The volume of fluid or air is determined by accumulated encoder counts. Software also polls the sensor input ports every motor revolution to check for conditions in which air is present from the beginning. Such a condition would result in no interrupt. An alarm occurs if the total amount of air exceeds a threshold value.

Additional information on air-in-line alarm algorithms and threshold methods is included in the Operating Instructions. Self-test is performed during the fill stroke by switching to a nonresonant frequency which simulates the presence of air.

Figure 2-16. Block Diagram of Cassette I.D. and Latch Sensors (Model2860)

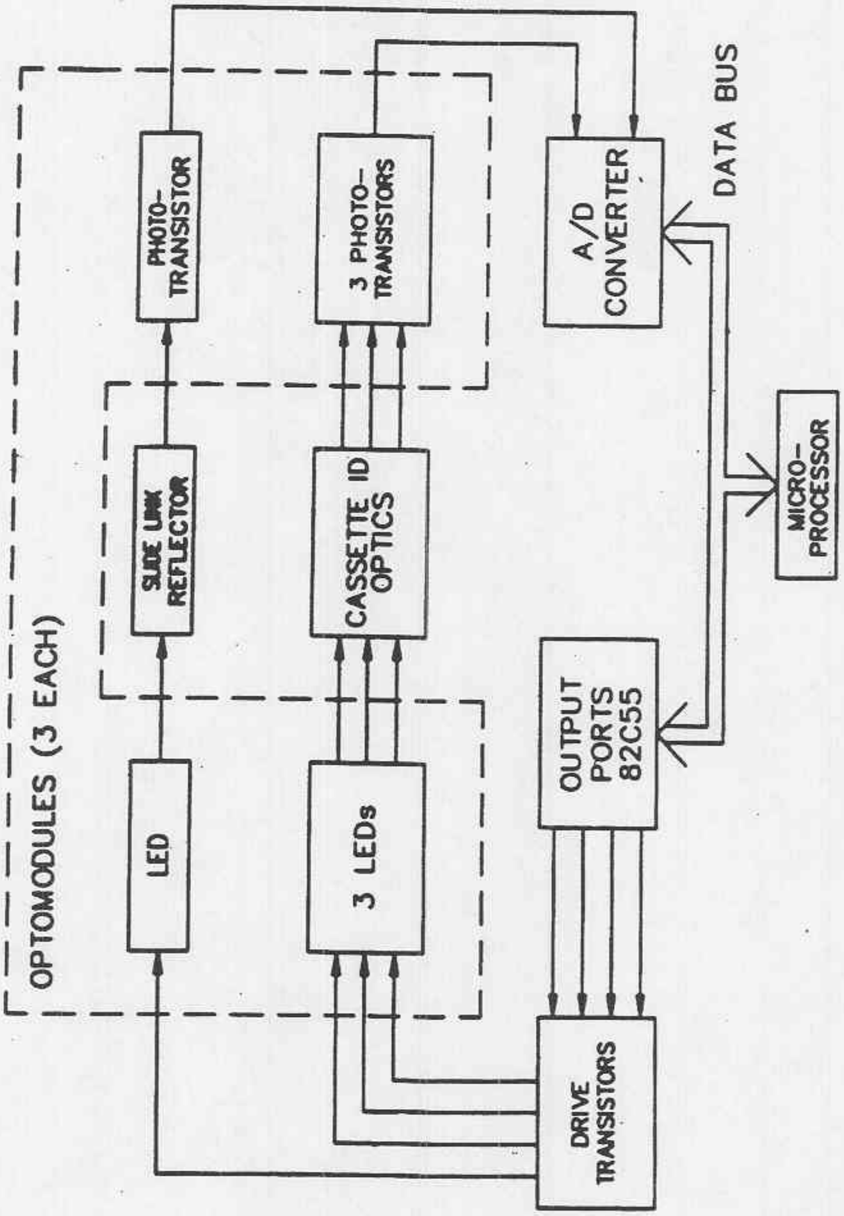


PHOTO-TRANSISTOR
3 PHOTO-TRANSISTORS
A/D CONVERTER
DATA BUS
SLIDE LINK REFLECTOR
CASSETTE ID OPTICS
MICRO-PROCESSOR
OPTOMODULES (3 EACH)
LED
3 LEDs
OUTPUT PORTS 82C55
DRIVE TRANSISTORS

Figure 2-16a. Block Diagram of Cassette I.D. and Latch Sensors (Model2863)

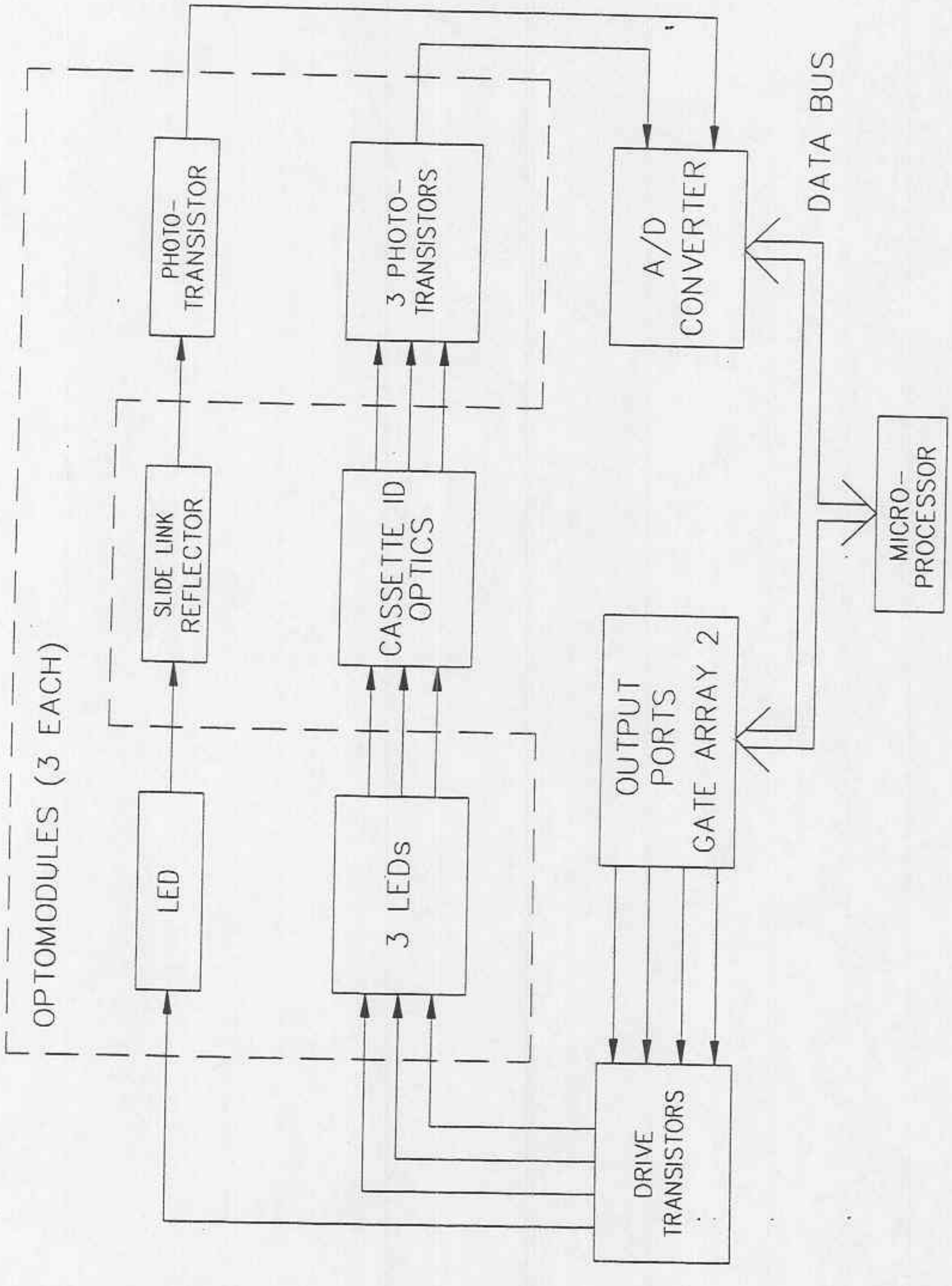

OPTOMODULES (3 EACH)
LED
SLIDE LINK REFLECTOR
PHOTO-TRANSISTOR
3 LEDs
CASSETTE ID OPTICS
3 PHOTO-TRANSISTORS
A/D CONVERTER
DATA BUS
MICRO-PROCESSOR
OUTPUT PORTS GATE ARRAY 2
DRIVE TRANSISTORS

Figure 2-17. Block Diagram of Air-in-line Sensor System (Model 2860)

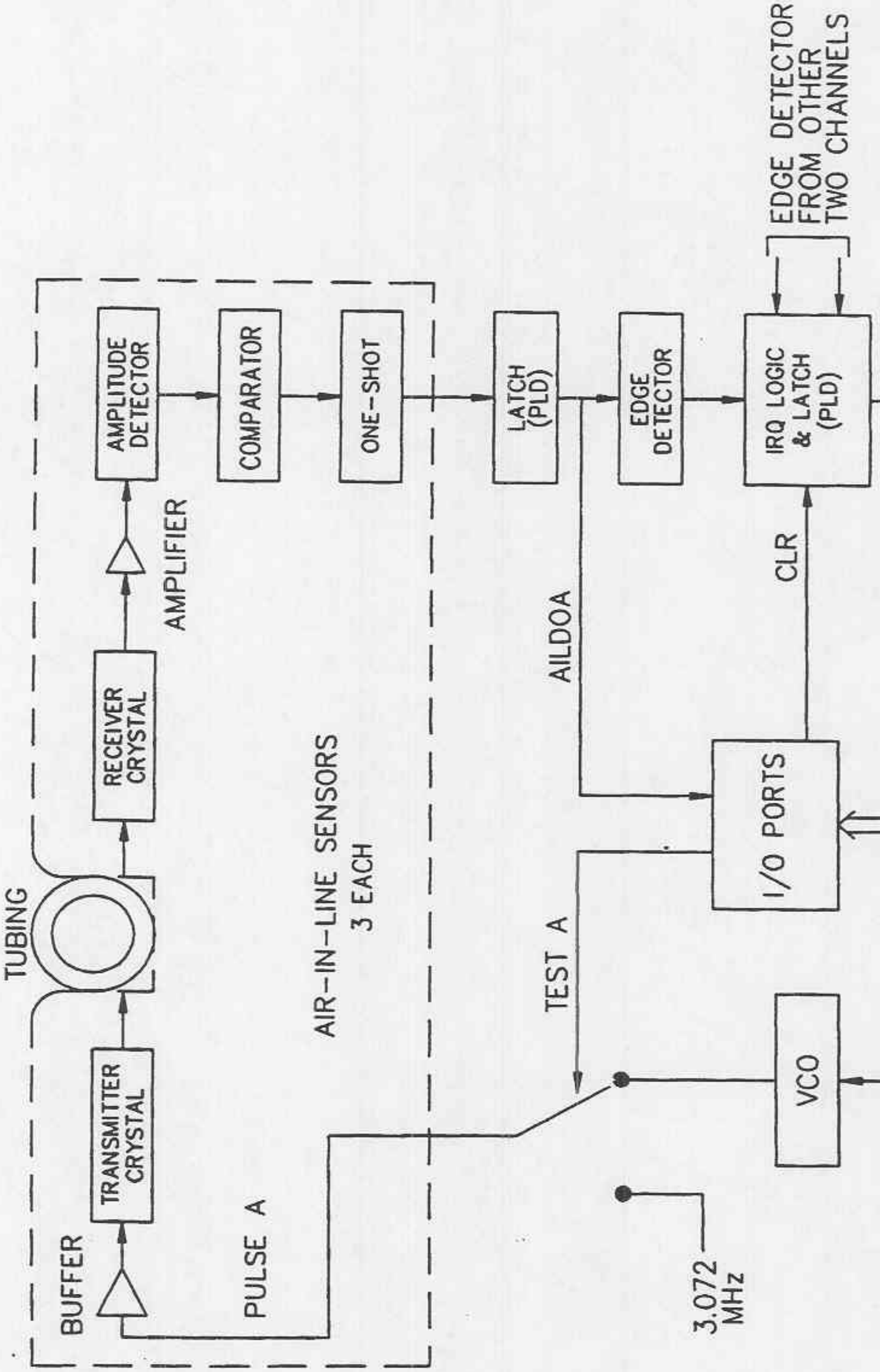
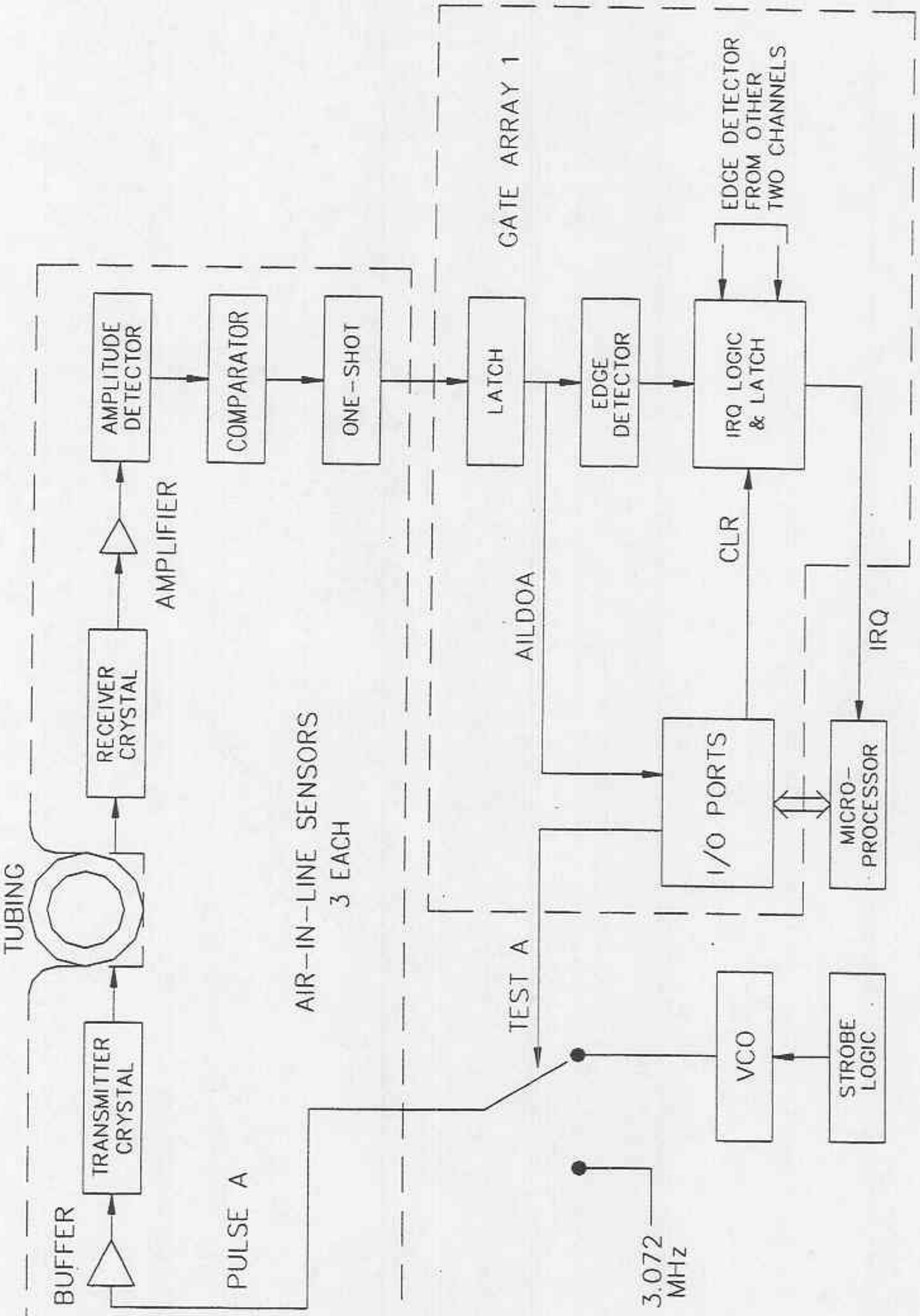

EDGE DETECTOR FROM OTHER TWO CHANNELS
AMPLITUDE DETECTOR
COMPARATOR
ONE-SHOT
LATCH (PLD)
EDGE DETECTOR
IRQ LOGIC & LATCH (PLD)
AMPLIFIER
AILDOA
CLR
IRQ
RECEIVER CRYSTAL
I/O PORTS
MICRO-PROCESSOR
TUBING
AIR-IN-LINE SENSORS 3 EACH
TEST A
TRANSMITTER CRYSTAL
VCO
STROBE LOGIC
BUFFER
PULSE A
3.072 MHz

Figure 2-17a. Block Diagram of Air-in-line Sensor System (Model 2863)


GATE ARRAY 1
EDGE DETECTOR FROM OTHER TWO CHANNELS
TUBING
AMPLITUDE DETECTOR
COMPARATOR
ONE-SHOT
LATCH
EDGE DETECTOR
IRQ LOGIC & LATCH
AMPLIFIER
RECEIVER CRYSTAL
AILDOA
CLR
IRQ
I/O PORTS
MICRO-PROCESSOR
AIR-IN-LINE SENSORS 3 EACH
TEST A
VCO
STROBE LOGIC
TRANSMITTER CRYSTAL
BUFFER
PULSE A
3.072 MHz

C. Patient-side Occlusion Detection

Occlusions between the pump and the patient are detected from measurements of pressure in the line. A semiconductor strain gauge pressure transducer is mounted in the chassis. The elastomeric pressure sensing dome in the cassette (see Figure 2-2) transmits pressure to the transducer. The power to the strain gauge is strobed to reduce power consumption.

The transducer output is amplified and low-pass filtered (see Figure 2-18). This switched capacitor filter attenuates motion artifacts and smoothes arterial pressure waveforms. The filtered signal is sampled by the A/D converter. The microprocessor uses calibration constants to convert A/D counts to the correct pressure units. Zeroing is performed each time the cassette is removed. Alarm thresholds are determined using either a baselining or absolute method, depending on the Device Type setting (refer to the Directions For Use).

Self-tests are performed to determine if there is a fault condition in the transducer. The strain gauge is tested by measuring the common mode output voltage from one leg of the bridge. Limits are also placed on the maximum allowable zero offset.

D. Fluid-side Occlusion Detection

Occlusions between the container and the pump may occur due to a closed regulating clamp, a closed vent (with an unvented container), kinked tubing, an empty syringe, or any restriction to flow. The fluid-side occlusion detection system detects these conditions, as well as empty syringes. The system is based on integrating the motor current during the fill portion of the pumping cycle (see Figure 2-19). During an occlusion on the container side, the motor draws more current and slows down. Current is sensed by a 1-ohm shunt resistor in the motor return line. The current is integrated using an operational amplifier with a feedback capacitor. Integrator mode (i.e., reset, integrate, or hold) is controlled by encoder markers that operate transmission gate switches. The leading edge of the home marker resets the feedback capacitor. At the trailing edge of the home marker, the transmission gate switches are configured to perform integration. At the rising edge of the DEL marker, the integration is stopped. This places the output in hold. When software detects the delivery stroke, by polling the DEL input port, the A/D converter reads the integrator output. If the sampled value exceeds the alarm threshold that is computed using calibration data and an occlusion detection algorithm, an alarm occurs. Note that measurements are always made with the motors operating at 5V. When infusing at high rates (i.e., greater than 275 ml/h), which uses the 13V drive, every fifth motor pulse uses 5V for one revolution.

2.7 Power Supply

Power is supplied to the instrument by a system that consists of an AC adapter, rechargeable nickel cadmium (NiCd) battery pack, and a regulating power supply module. The power supply module is comprised of seven basic elements: four power converters, a battery charger, an on/off circuit, and a power control switch (see Figure 2-20).

A. Alternating Current Adapter

The AC adapter converts line voltage into unregulated 9V DC power (unloaded), referred to as Vext. The AC adapter is external to the instrument and connects to the power module board via the audio/connector PCBA. The internal transformer isolates the instrument. This results in leakage current of less than 100 microamperes. The output of the transformer is full-wave rectified by a diode bridge, and low-pass filtered by electrolytic capacitors. A nonresettable thermal fuse is incorporated in the primary winding of the transformer to protect against fault conditions. The AC adapter also provides earth grounding.

Figure 2-18. **Block Diagram of Patient-side Occlusion Detection System Circuit**

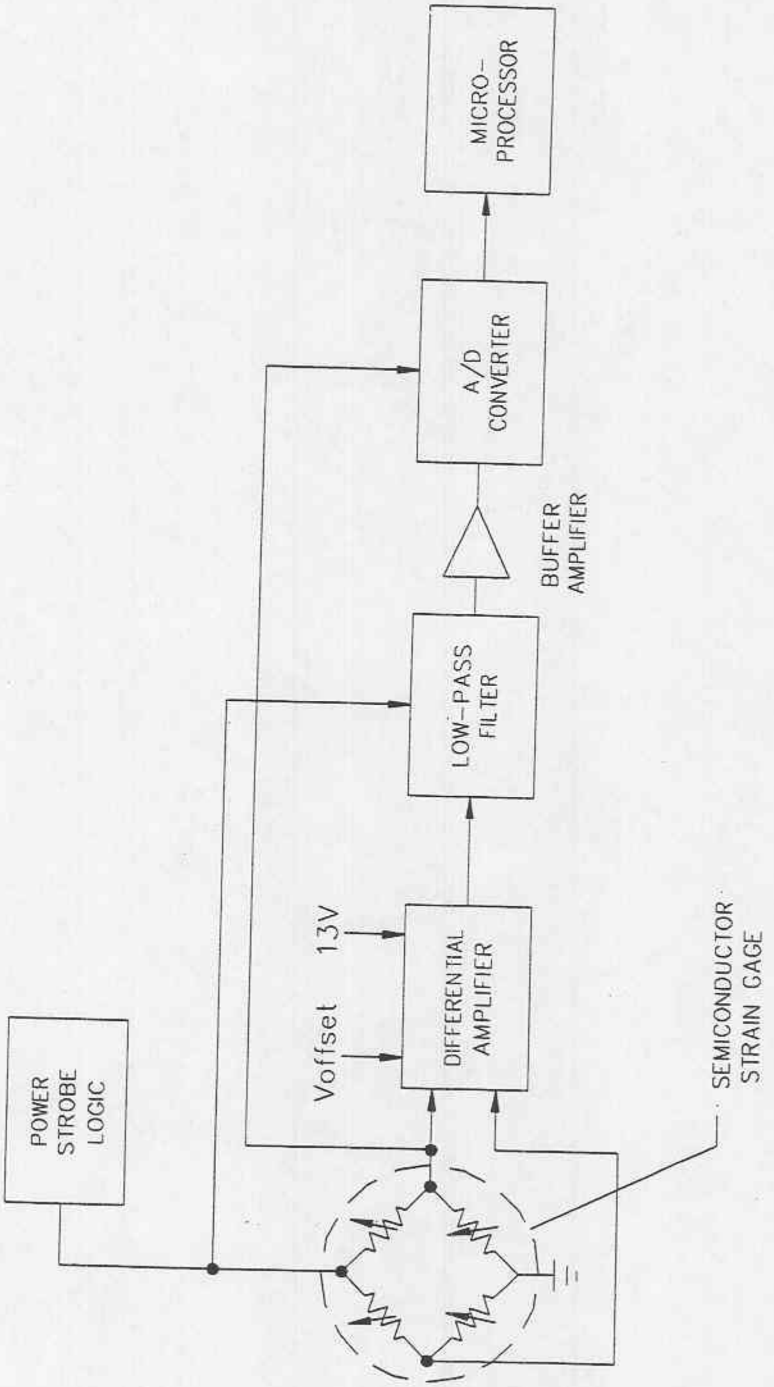

MICRO-PROCESSOR
A/D CONVERTER
BUFFER AMPLIFIER
LOW-PASS FILTER
13V
Voffset
DIFFERENTIAL AMPLIFIER
SEMICONDUCTOR STRAIN GAGE
POWER STROBE LOGIC

Figure 2-19. Block Diagram of Fluid-side Occlusion Detection System Circuit

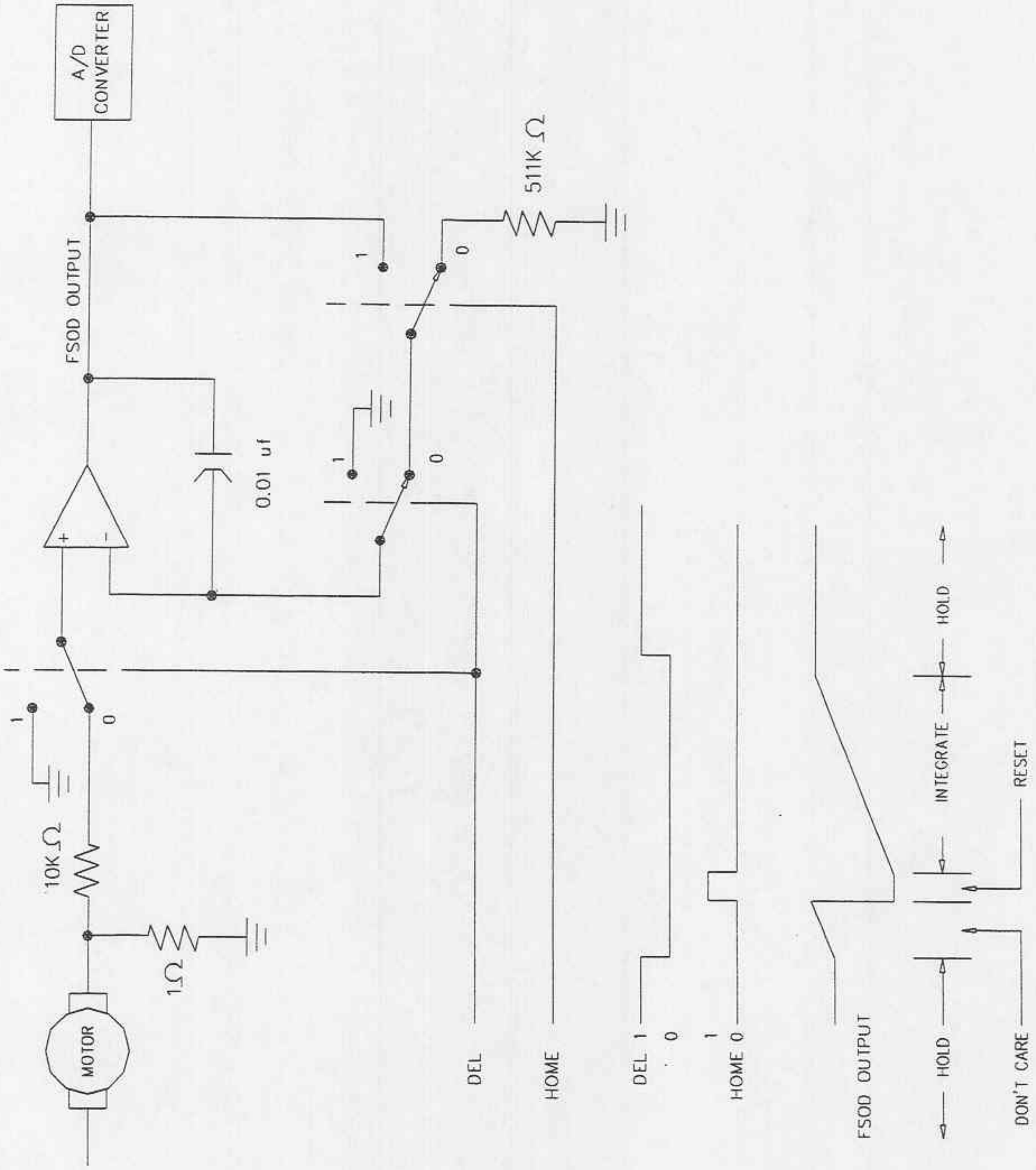
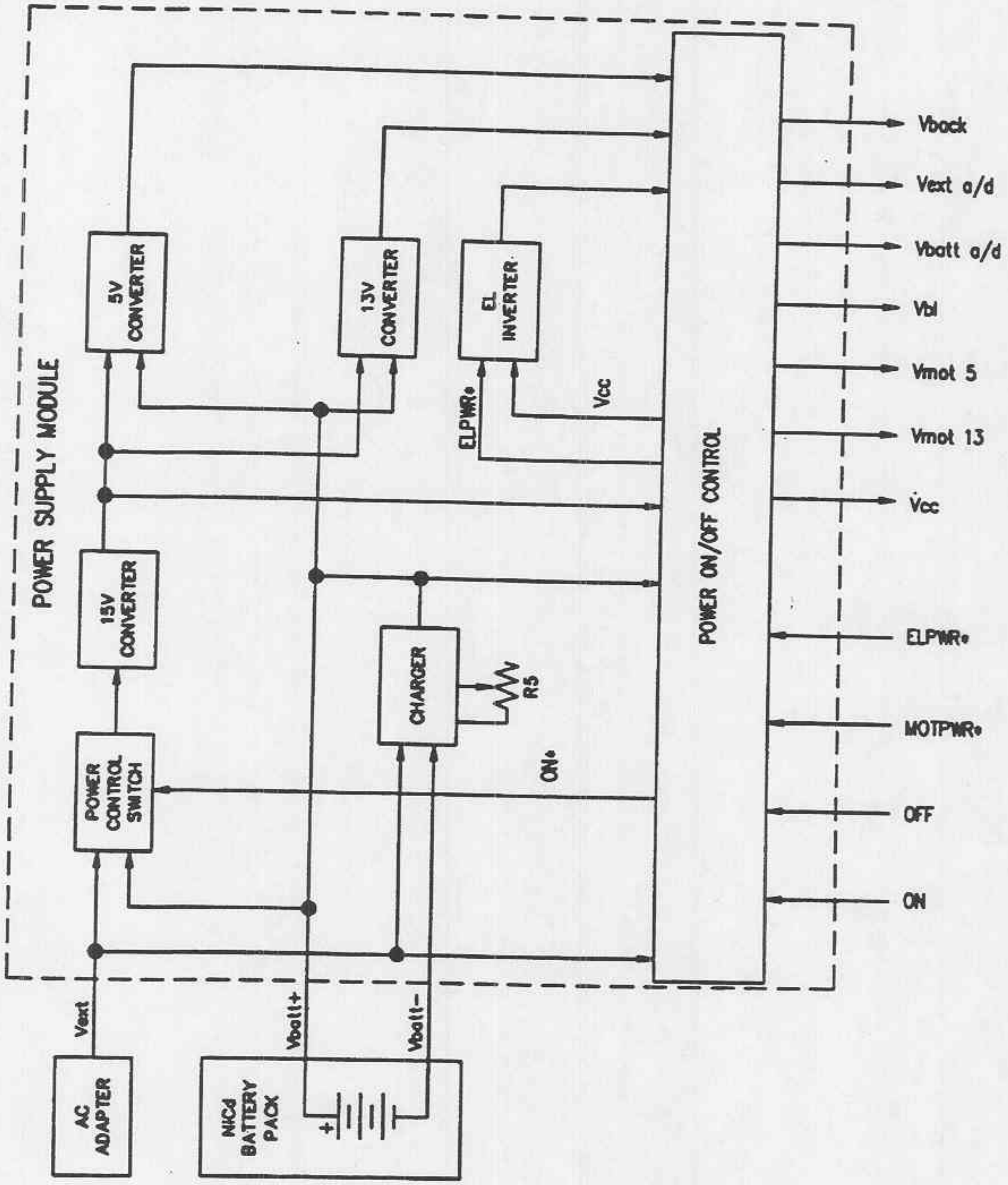

A/D CONVERTER
FSOD OUTPUT
511K Ω
1
0
0.01 uf
+
-
1
0
1
0
10K Ω
1Ω
MOTOR
DEL
HOME
DEL 1
0
1
HOME 0
FSOD OUTPUT
HOLD
INTEGRATE
HOLD
DON'T CARE
RESET

Figure 2-20. Block Diagram of Power Supply Module


POWER SUPPLY MODULE
5V CONVERTER
13V CONVERTER
EL INVERTER
Vcc
ELPWR*
POWER ON/OFF CONTROL
15V CONVERTER
CHARGER
R5
ON*
POWER CONTROL SWITCH
Vback
Vext a/d
Vbatt a/d
Vbl
Vmot 5
Vmot 13
Vcc
ELPWR*
MOTPWR*
OFF
ON
Vext
AC ADAPTER
Vbatt+
Vbatt-
NiCd BATTERY PACK

B. Nickel Cadmium Batteries

Without Vext, the instrument is powered by three 1700-mAh rechargeable NiCd cells connected in series. The three cells are contained in the battery pack attached to the top of the main housing. Nominal voltage is 1.2V per cell. A self-resetting thermal fuse is included in the battery pack to protect against fault conditions. The batteries connect directly to the power PCBA. The inside of the battery pack housing is coated with a thin layer of aluminum to provide shielding against electromagnetic interference and electrostatic discharges.

WARNING

Failure to use MedSystem replacement batteries can cause false low-battery alarms.

C. Power Converters

The four power converters generate +5V and +13V for the MedSystem III electronics and motors, AC power to drive the electroluminescent (EL) backlight panel behind the front panel LCD, and +15V for use in the power supply module. The 5V and 13V circuits convert unregulated battery voltage into regulated voltage of 5V and 13V DC. This is accomplished by using two step-up switching regulators (MAX643) with over-voltage protection. The 15V circuit converts unregulated AC adapter and battery voltage to regulated 15V DC power. This then supplies the high-voltage gate drive to MOSFET switches elsewhere in the power supply. The 15V converter is a boost regulator that uses a MAX643 step-up switching regulator configured for bootstrapped operation. The EL power converter transforms +5V DC power from the power on/off circuit to 80 Vrms, 400-Hz AC power, using a tank circuit and a step-up transformer.

Backlighting power is controlled by the output port ELPWR*. The EL inverter output is applied directly to the EL backlighting panel located behind the LCD.

D. Power Control Switch

The power source to the 15V converter is determined by the control switching circuit. When the AC adapter is plugged into the instrument, Vext is applied to the 15V converter by the external power control circuit. A metal-oxide varistor (MOV) protects input circuitry from high-voltage transients. Without Vext, Vbatt is gated to the 15V converter.

E. Charger Circuit

Whenever the AC adapter is used, the charging circuit restores the NiCd battery charge, and simultaneously powers the instrument. A step-up/step-down regulator converts power from Vext to the battery. It also supplies current to the battery and the 5V and 13V converters. Charge current is regulated by a feedback circuit that senses current in the negative battery terminal. The charge rate is set to an average current of 170 milliamps by potentiometer R5.

F. Power On/Off Control Circuit

The power on/off circuit controls the power supply module outputs. When the ON signal is strobed by the keypad, the power on/off circuit asserts ON*, powering up the 15V converter. The presence of 15V activates the +5V and +13V converters.

Five volts is immediately provided to the MEA, powering up the microprocessor system. Signals MOTPWR* and ELPWR* from an output port determine when the +13V and 80 Vrms supplies are asserted as outputs from the power supply module.

When the OFF signal is strobed by the microprocessor, ON* goes high, disconnecting all power module outputs; thereby, powering down the MEA. Power supply circuits are isolated from the MEA by MOSFET switches.

G. Monitoring the Power Supply

Two signals from the power supply module are monitored by the microprocessor via the A/D converter. The Vext A/D signal is used to determine whether the AC adapter is powering the instrument. The Vbatt A/D signal provides battery charge information. These two signals are used to initiate or suppress low-battery advisories and alarms.

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Chapter 3
System Functional Tests

3.0 System Functional Tests

Functional tests are recommended prior to clinical use, after repair or calibration, and annually as part of annual preventive maintenance. When a test requires a primed cassette, it is recommended that saline solution be used for such tests. If any of the functions are not as described in the check procedures, then the instrument requires service. Refer to Chapters 1 and 2 for diagrams which illustrate component names and placement of parts. Refer to Chapter 6 for information on troubleshooting specific problems. See Section 6.4 for a cross-reference listing of event codes and problems.

WARNING

For proper grounding, the AC adapter must always be connected to a three-wire outlet. Never operate the MedSystem III System from a two-wire, ungrounded outlet.

WARNING

Do not perform any of the following tests while the system is in use on a patient. Review all precautions in the Directions for Use before performing these tests.

NOTE: *Upon completion of system functional tests, reset the following: Volume Remaining, Time, and Rate.*

3.1 Electrical Safety Test

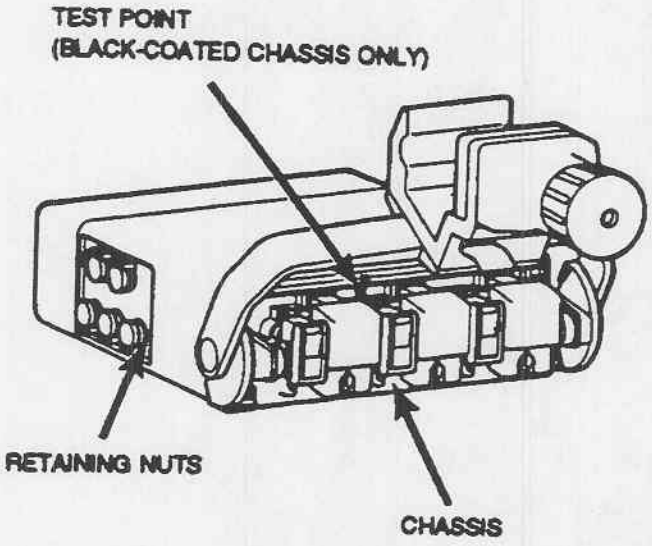
Tests for leakage current and for ground continuity are recommended in accordance with the requirements listed under NFPA99, UL 544, and ANSI/ AAMI ES1, 7/85. The suggested grounding point on the instrument for these tests is the chassis (see Figure 3-1).

NOTE: *Electrical safety test can only be performed with AC adapter connected to the unit.*

NOTE: *The pole clamp is isolated from the internal electronics and, therefore, is not grounded. It should not be used while performing electrical safety tests.*

NOTE: *The chassis of some instruments is coated with a black protective material that is nonconductive. If your instrument has this coating, use the uncoated test point located toward the back of the chassis under the lower housing (see Figure 3-1).*

Figure 3-1. Test Point for Instrument with Black-coated Chassis



3.2 Power Tests

A. Power-up Test

Charge the instrument for at least one hour before performing this test.

Proceed with the power-up test as follows:

1. Disconnect the AC adapter from the instrument.
2. Remove any cassettes installed in the instrument.
3. Turn the instrument on and verify proper power-up, as described in the MedSystem III™ Directions for Use.
4. The instrument performs initial self-test during power-up; and, if it detects any problems, it will indicate a fault.
5. Check audio and keypad operation by ensuring there is a soft beep for each key press.
6. Press any key and ensure the LCD backlight turns on.

NOTE: *For a complete memory self-test, the instrument should be turned on for a minimum of 10 minutes for the Model 2860 and 18 minutes for the Model 2863 instruments. It is not necessary for the unit to be pumping to perform this test. If operating on battery power, a cassette must be installed in at least one of the channels and that channel put in standby mode; otherwise, the instrument will automatically shut off after five minutes of inactivity.*

B. AC Power Test

1. Turn on the instrument without the AC adapter attached.
2. Install a primed cassette in each pump channel.
3. Start all channels (at any rate). Verify the green LED on each channel blinks during operation.

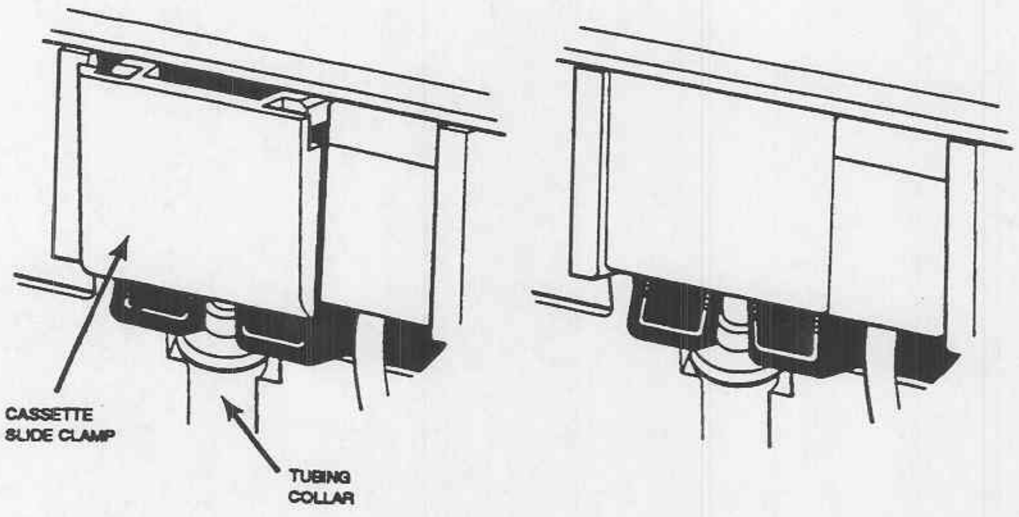
4. Attach the AC adapter to the pump. Verify that the instrument beeps three times when the connector is properly installed. Verify that the green plug-shaped light on the side connector panel is lit and does not blink if you wiggle the connector.
5. Verify that the green LEDs for each channel key (A, B, and C) are steadily illuminated. If they are blinking, then the instrument is not recognizing that AC power is connected.

3.3 Cassette and Sensor Test

This test verifies the proper functioning of the cassette and latch sensors, as well as the latching mechanisms. Repeat the following procedures for all three channels (A, B, and C).

1. With the instrument off, remove any cassettes that are installed in the instrument.
2. Turn on the instrument.
3. Verify that the pump latch mechanism of each channel returns to the Home position at the top of the stroke (nearest to the chassis).
4. Press the channel select key (A, B, or C), and then press the START/STOP key. A two-tone advisory will sound, and the highlighted message *Install Cassette* will appear in the prompt line near the bottom of the screen.
5. Install a primed cassette into the appropriate channel (A, B, or C), but do not push the cassette slide clamp into place (see Figure 3-2A). Ensure that there are no air bubbles.
6. Again press the START/STOP key. A two-tone sound will be emitted, and the message *Push slide clamp in* will appear at the bottom of the page.
7. Push the cassette slide clamp in (see Figure 3-2B), and seat the tubing collar in the recess below the cassette. Three beeps will sound to indicate correct cassette installation and fluid in the sensor pathway. The cassette should latch easily and smoothly. If the air-in-line sensor detects air when a cassette is installed, a *Check Air Sensor* advisory will be displayed.
8. Press the START/STOP key. The message *Infusing* will appear on the channel status line.
9. While the channel is pumping, pull out the cassette slide clamp. You will hear a repeating four-beep audio alarm and the red LEDs will blink. Infusion will stop and the display will indicate a *Cassette Not Latched* alarm.
10. Remove the cassette. The alarm display should read *Cassette Removed.* Reset the alarm by pressing the channel select key (A, B, or C) for the channel in use, and press the CANCEL softkey.

Figure 3-2. Cassette Installation



A. SLIDE CLAMP NOT IN PLACE

B. SLIDE CLAMP IN PLACE

3.4 Patient-side Occlusion Detector Test

This test verifies the proper functioning of the alarm which detects occlusion between the instrument and the patient. Repeat the following steps for each of the three channels, A, B, and C.

1. Connect a set to a fluid container and prime. Ensure there are no air bubbles.
2. Ensure the instrument is turned on.
3. Install the primed set.
4. Press the appropriate channel key (A, B, or C) to select the programming page for the channel to be tested.
5. Set the infusion rate for the selected test channel to 125 ml/h, and set the volume remaining to 100 milliliters.
6. Ensure that the roller clamp is open and caps are removed. Press the START/STOP key and verify that fluid is flowing.
7. Fold and pinch the patient-side tubing just below the instrument.

   When the patient-side occlusion is detected, the Standard Display will show an alarm for the test channel and will also show the message *Patient Side Occluded.* The red LED in the key for the test channel will blink, and an audible four-beep alarm will sound.
8. Release the tubing and press the START/STOP key to reset the alarm.

NOTE: *A more accurate patient-side occlusion test can be performed by configuring the instrument in the Controller Pressure Device Type, which has an absolute nominal occlusion pressure of three feet of water (see Directions for Use). Use a set which contains no filters or check valves, and which has macro bore tubing on the patient side. Set the infusion rate for 1 ml/h, and raise the patient-side tubing outlet two feet, two inches above the cassette. The channel should not sound an alarm. Next, slowly raise the tubing outlet three feet, eight inches above the cassette. The channel should sound an alarm within 10 seconds.*

3.5 Fluid-side Occlusion Detector Test

This test verifies the proper functioning of the alarm that detects occlusions between the instrument and the fluid container. Repeat the following procedure for each of the three channels, A, B, and C.

1. Install a primed set in the selected channel.
2. Start the selected channel at 125 ml/h.
3. Close the roller clamp between the instrument and the fluid container. The occlusion should be detected within two minutes.
4. The Standard Display screen will show an alarm for the channel under test and also the message *Fluid Side Occluded*. The red LED in the key for the test channel will blink, and an audible four-beep alarm will sound.
5. Open the roller clamp and press the START/STOP key to reset the alarm.

3.6 Air-in-line Detector Test

This test verifies the proper functioning of the alarm which detects air in a line.

Repeat the following procedure for each of the channels, A, B, and C.

1. Disconnect the drip chamber from the solution bottle, or inject a large air bubble into the tubing via the upstream y-site.

   NOTE: *The injected air bubble size should be approximately twice the threshold value of the air detector plus one milliliter to fill the cassette air trap. For example, if the threshold is 500 microliters, then inject a 2-milliliter air bubble. To determine the threshold value, check the Clinical Configuration settings in the instrument (see Directions for Use).*

2. Press the START/STOP key on the selected cassette. When the bubble is pumped through the cassette, the Standard Display should show an alarm for the channel under test with the message, *Air In Line*. An audible four-beep alarm will sound and the red LEDs will blink.

3.7 Volume Accuracy Test

Accuracy of fluid delivery is determined by measuring the volume of fluid delivered over a known time period and comparing this measurement to the expected value. To ensure accurate measurements during this test, a volumetric glass burette (class A) must be used to collect the fluid. The infusion time interval, which is measured manually with a stopwatch with a precision of 0.1 second, must be 180 seconds or greater to minimize measurement errors. During a 180-second test, a one-second error by the operator results in an error of 0.6%.

The expected volume is calculated from the programmed rate and the measured time interval. The volume collected should be large enough to minimize errors in reading the burette. See Table 3-1 for the test parameters recommended by the AAMI proposed infusion device standard.

WARNING

Proper operation of the valve actuator return springs is essential for accurate fluid delivery when using negative input pressures. Negative input pressures occur as a result of negative head heights, viscous solutions, or syringe use.

Checking the spring function is accomplished by testing volume accuracy, using conditions of negative head height (at least -2.5 feet) and a rate greater than 275 ml/h. These conditions are recommended for annual functional tests, or if the valving mechanism was disassembled.

Table 3-1. Volume Accuracy Test Parameters

Rate (ml/h)	Minimum Collection Volume (ml)	Nominal Collection Time (min.)	Burette Size (min.)
5	10	120	10
10	10	60	10
50	25	30	25
100	25	15	25
250	50	12	50
500	50	6	50
999	50	3	50

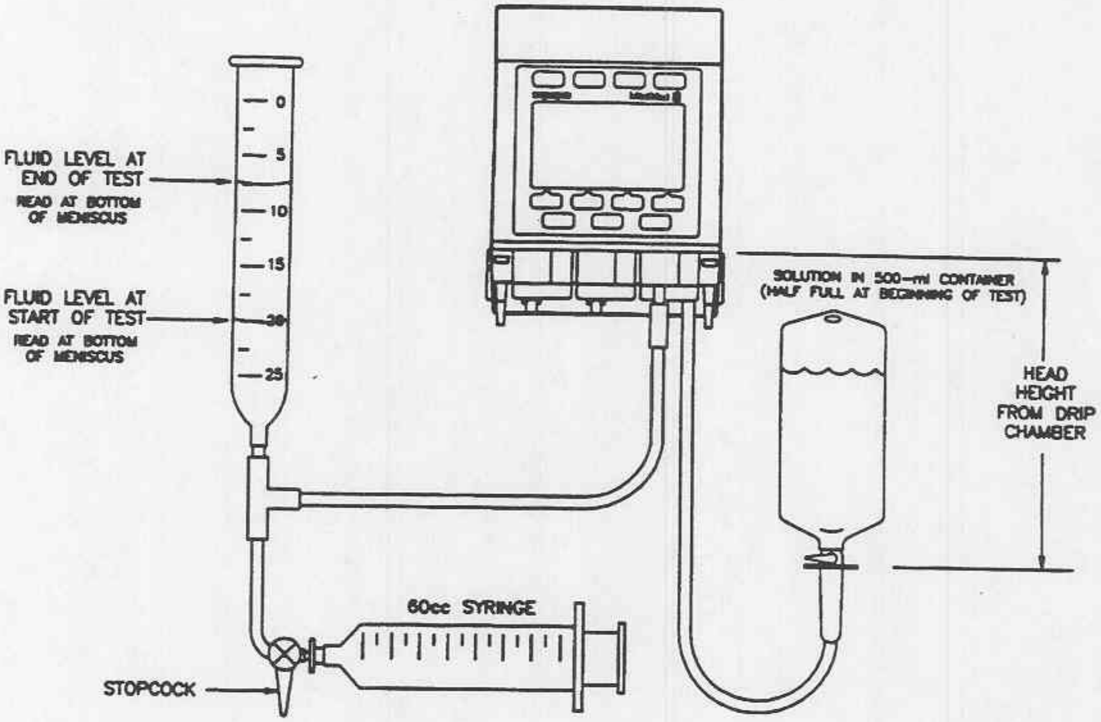
NOTES:

1. Interpolation shall be to the next lower specified flow rate's collection volume, and collection time shall be the collection volume divided by the flow rate.
2. If the flow rate to be tested falls between two specified rates, choose the collection volume for the next lower rate. For example, to test at 150 ml/h, choose a collection volume of 25 ml in a burette of 25 ml, with the resulting collection time being 10 minutes.

A. Test Equipment Setup

1. Obtain a new set and connect it to a 500-milliliter container which is at least half full. Prime the set and eliminate all air.
2. Connect the apparatus as shown in Figure 3-3. Use a volumetric burette marked in 0.1-milliliter increments (class A glassware).
3. Install the cassette into the channel being tested. If testing valve actuator springs, adjust the fluid level in the container to at least 2.5 feet below the cassette.

Figure 3-3. Test Equipment Setup


FLUID LEVEL AT END OF TEST
READ AT BOTTOM OF MENISCUS
FLUID LEVEL AT START OF TEST
READ AT BOTTOM OF MENISCUS
0
5
10
15
20
25
SOLUTION IN 500-ml CONTAINER (HALF FULL AT BEGINNING OF TEST)
HEAD HEIGHT FROM DRIP CHAMBER
60cc SYRINGE
STOPCOCK

B. Calculations

Vm = Volume measured (ml) = (Initial fluid level - Final fluid level)
R = Rate (ml/h)
T = Time interval measured (seconds)
Ve = volume expected (ml)

Ve = R•T/3600
% Error = 100•(Vm - Ve)/Ve

C. Procedure

1. Set the rate to the desired value for the channel being tested. Set the volume remaining greater than the expected volume (e.g., 100 ml) to ensure the infusion does not switch to a keep vein open (KVO) rate during testing.
2. Open the stopcock to the syringe and adjust the bottom of the meniscus to a convenient level. Record this level. Close the stopcock.
3. Simultaneously start the infusion and stopwatch.
4. When the infusion time is near nominal collection time, simultaneously stop the infusion and stopwatch.
5. Read the fluid level at the bottom of the meniscus and record this value. Read the stopwatch time and record the value.
6. Calculate the volume delivered, the volume expected, and the percent of error. For Device specifications, see Appendix A.

Example:

Rate = 500 ml/h
Initial fluid level = 50.0 ml
Measured time = 350 sec.
Final fluid level = 0.9 ml

Ve = R•T/3600 = 500•350/3600 = 48.61 ml
Vm= 50.0 - 0.9 = 49.1 ml

% Error = 100•(Vm - Ve)/Ve
= 100•(49.1 - 48.61)/48.61
= 1.0%

3.8 Battery Operating Time

Perform the following procedures to test battery life.

1. Ensure that the instrument has been charged for 14 continuous hours prior to performing this procedure.
2. Turn the instrument on with an AC adapter connected. Disconnect the AC adapter. Run the instrument at 125 ml/h concurrently on all three channels: A, B, and C (a total of 375 ml/h).

   NOTE: *Key presses and alarms during the test period can result in reduced battery operating time. Therefore, minimize these events during this test.*
3. Assure that a Low Battery advisory does not occur for at least 5.5 hours of operating time.
4. Assure that a Battery Depleted alarm does not occur for at least 30 minutes after the onset of the Low Battery advisory.
5. Assure that the Battery Depleted alarm continues for at least five minutes before the instrument shuts off.
6. Recharge the instrument for 14 hours.

The Battery History Log automatically records the time intervals required by the above test.

3.9 Watchdog Audio Test

Manually test the Watchdog Alarm Audio from the Standard Display. Press the More Options button several times until a softkey labeled Demo WD appears. Press this key and follow the directions on the screen for completing the Watchdog Test.

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Chapter 4
Maintenance

4.0 Maintenance

The MedSystem III Infusion System is designed for reliable, long-term operation. However, annual preventive maintenance is required to maintain optimum performance and to detect the need for repair or adjustment. Preventive maintenance regimes are typically established by your institutional policies. These policies should consider local experiences and usage patterns.

4.1 Cleaning Procedure

> ***WARNING***
>
> *Before cleaning, unplug the AC adapter from the AC wall outlet and from the instrument.*

> ***CAUTION***
>
> *DO NOT STEAM STERILIZE, ETO STERILIZE, OR AUTOCLAVE THE INSTRUMENT. DO NOT IMMERSE the instrument. DO NOT allow fluids to enter the instrument. Ensure that the instrument is kept in an* ***upright position*** *when cleaning to prevent fluids from possibly leaking into the instrument. The MedSystem III is designed to be splash-proof only. Inspection should be performed before cleaning to ensure that there is no damage that could cause fluid to enter the case interior.*

> ***WARNING***
>
> *Never apply alcohol to a cassette intended for patient use.*

The steps which follow should be used to keep the instrument clean.

A. Cleaning Solutions

> ***CAUTION***
>
> *DO NOT use organic solvents, ammonia, or ammonium-based agents for cleaning. Isopropyl alcohol may be used for wiping specified external surfaces only, as directed in the MedSystem III manuals. Prolonged or repeated exposure to isopropyl alcohol can damage plastic parts. Refer to warning in Appendix H-1.*

Refer to the Environmental Services, Central Service, or Infection Control Departments in your facility for further information on appropriate cleaning agents.

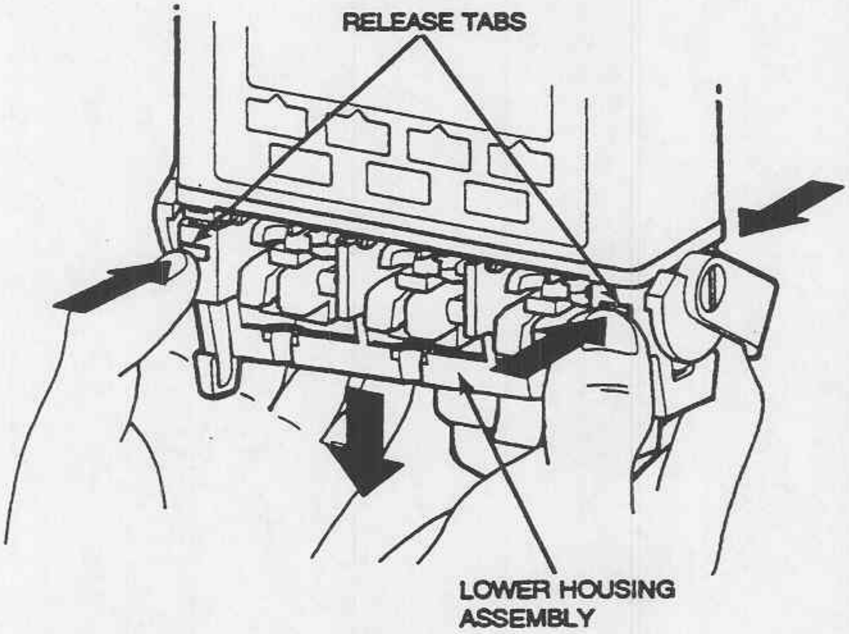
B. Instrument Exterior

Routinely clean the exterior surfaces of the instrument. Use a cloth dampened with warm water and a mild, nonabrasive, nonstaining standard hospital disinfectant or a detergent (i.e., commercially available dishwashing liquid). Dilute the disinfectant or detergent with water. Isopropyl alcohol may be used to wipe the housing exterior.

C. Lower Housing and Pumping Mechanism

To access these components, first remove the lower plastic housing by depressing the four black release tabs in the upper corners. Next, pull straight down (see Figure 4-1). A small soft-bristled brush helps in cleaning the pump latch mechanism and linkages. If the slide link or pump latch mechanisms stick, spray with an acceptable cleaning solution (see Figure 4-2). To loosen severely contaminated mechanisms, let cleaning solutions permeate for an extended time. Thoroughly dry the mechanisms after cleaning, using clean pressurized air.

Figure 4-1. ***Lower Housing Removal for Pumping Mechanism Access***



D. Air-in-line Sensor

The air-in-line sensor tubing recess must be free of debris, dirt, or dried solutions. Wipe the tubing recess (see Figure 4-3) with a nonabrasive cloth, pad, or swab moistened with isopropyl alcohol. Remove excess alcohol with a dry, lint-free swab.

Figure 4-2. Contaminant Removal from Slide Link and Pump Latch Mechanisms

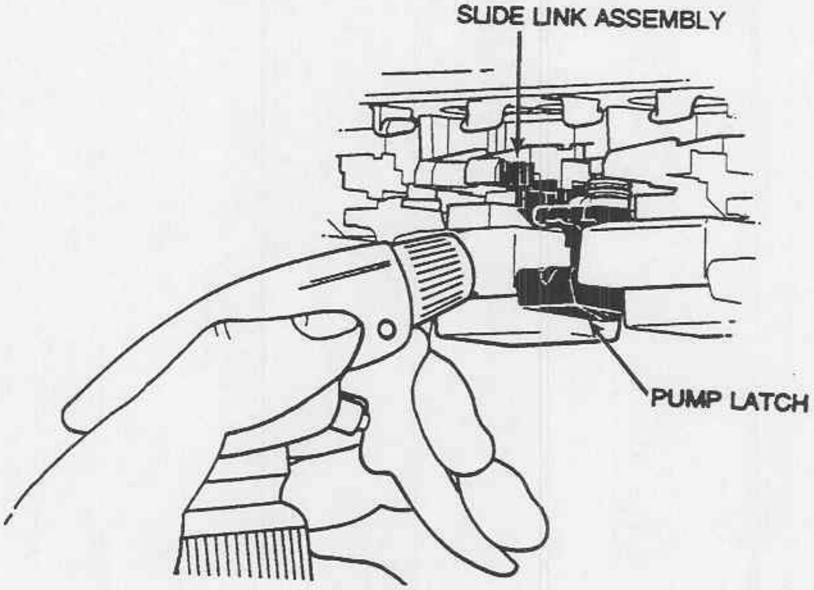
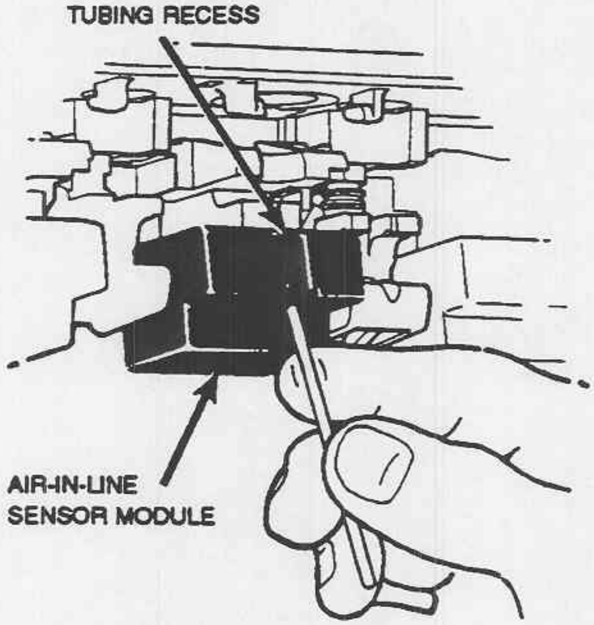

SLIDE LINK ASSEMBLY
PUMP LATCH

Figure 4-3. Contaminant Removal from Air-in-line Sensor Tubing Recess


TUBING RECESS
AIR-IN-LINE SENSOR MODULE

E. Optomodule

WARNING

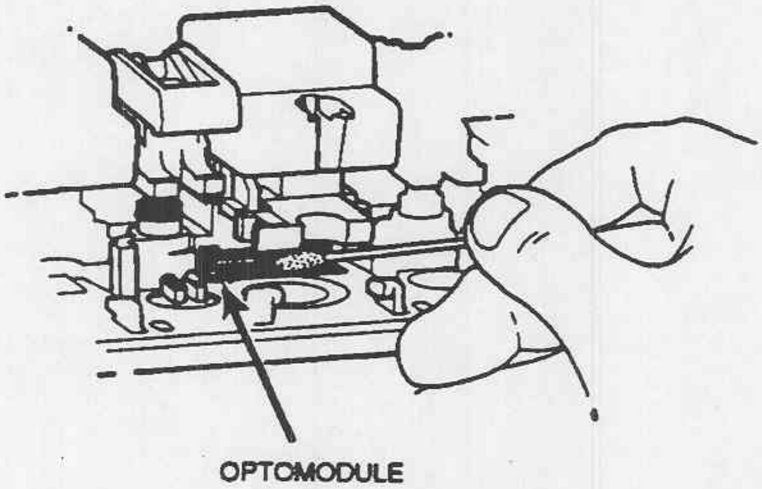
When cleaning the optomodule, use EXTREME CARE to avoid damage to valve actuators. If valve actuators are damaged, a free-flow condition could result.

Clean the optomodule with water or a very diluted mild detergent solution (see Figure 4-4). Wipe the surfaces dry with a lint-free swab.

CAUTION

DO NOT use isopropyl alcohol to clean the optomodule.

Figure 4-4. Contaminant Removal from Optomodule



F. Valve Actuators

CAUTION

Do not use organic solvents, ammonia, ammonium-based agents, isopropyl alcohol, and/or abrasive solutions for cleanings.

WARNING

Use EXTREME CARE when cleaning the valve actuators. Damage to the valve actuators can cause an uncontrolled flow condition. Do not clean with sharp or hard tools.

Clean the valve actuators with a non-abrasive, lint-free cloth and mild, non-abrasive, non-staining disinfectant or detergent. Dampen a swab with the cleaning solution. Gently remove any residue or contaminant from the valve actuators and the actuator seal, being extremely careful not to bend the valve actuators or tear the actuator seal. If dried residue is difficult to remove, perform the following steps (see Figure 4-5).

1. Set the pump upright and keep it upright while cleaning.

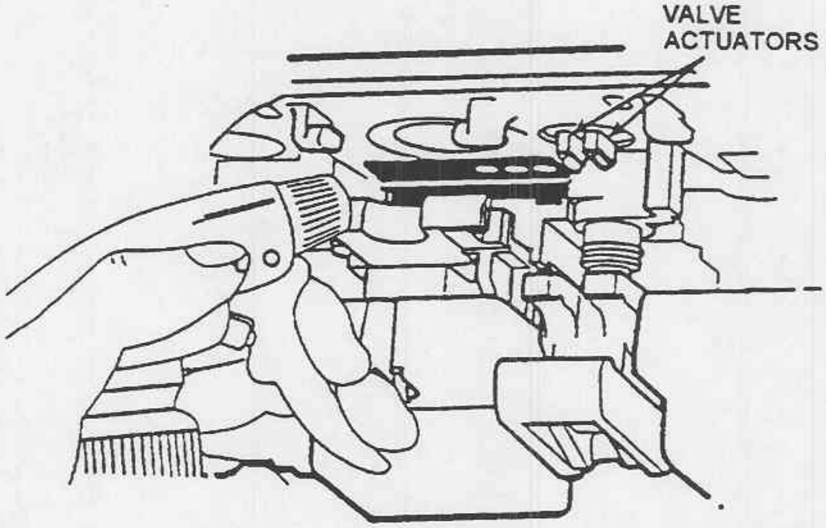
CAUTION

Ensure instrument is kept in an upright position when cleaning to prevent fluids from possibly leaking into the instrument.

2. Spray the cleaning solution on the residue.
3. Keeping the pump upright, allow the residue to soften.
4. Gently wipe away the softened residue with a dampened swab.
5. If necessary, repeat steps 2 through 4 until the residue is removed.

Rinse the valve actuators with water and wipe with a dry swab.

Figure 4-5. Contaminant Removal from Valve Actuators



After cleaning, inspect the exposed tips of the valve actuators for damage by lightly pushing the tips of the valve actuators side to side with a dry swab. If the tip is not rigid, it is broken and must be replaced before using the pump.

NOTE: A broken valve actuator tip may be supported by the actuator seal and may not appear defective.

4.2 Annual Maintenance

It is recommended that annual maintenance be performed on the instrument. Such maintenance should be completed in the order presented in sections A through H which follow.

CAUTION

Inspection should be performed before cleaning to ensure there is no damage that could cause fluid to enter the case interior.

NOTE: *The instrument should be cleaned before calibration to remove dirt, dried solutions, and debris from the sensors.*

WARNING

Functional tests should be performed at the completion of the annual maintenance check to ensure that the instrument performance is within the required specifications before being returned to patient use.

A. Inspection

Certain defects can be determined by inspecting the instrument. Check for the following defects.

1. AC Adapter

- AC power and ground prongs are not damaged or loose.
- Housing is intact, free of cracks, and the side of the case is not bulged or dimpled.
- Cable insulation is intact and not frayed or cut.
- Instrument connector shell is intact and pins are not damaged.

2. Pole Clamp

- Housing is not broken or cracked.
- Instrument front-to-back indexing is firm.
- Clamp rotates properly around the bracket.
- Clutch operates and is adjusted properly.
- Rubber pads are intact.

3. Loose Parts

- Shake instrument to ensure that there are no loose internal parts.

4. Main Housing

- There are no significant cosmetic defects.
- Labels are intact.
- Main housing is intact and free of cracks.
- Audio/connector PCBA dust covers are intact and free of cracks.
- Battery pack is flush with top of case and sealing gasket is not visible.
- Main housing is flush with chassis and sealing gasket is not visible.

5. **Front Panel**
   - Keypad is not damaged or delaminated.
   - Text on LCD is aligned evenly with keypad window (i.e., LCD is not crooked).
   - LCD is free of cracks.
6. **Lower Housing**
   - Housing is securely attached.
   - Housing is intact and free of cracks.
   - Lower housing clips are intact.
   - Chassis mounts are intact.
7. **Mechanisms and Sensors**

   First, clamp instrument to a table, remove lower housing, and rotate instrument so that the pumping mechanisms are on top. Ensure the following:

   - Air-in-line sensor modules are attached securely.
   - Air-in-line sensor tubing recess is thoroughly cleaned.
   - Slide links are clean and move freely.
   - Pump latch assemblies are intact and springs seated properly.
   - Pump latch assemblies open and close with a firm snap.
   - Pump shaft seals are seated.
   - Valve actuator tips are not damaged.
   - Valve actuator seals are not damaged and are seated properly.
   - Pressure transducers are seated and their tape covers intact.

B. Cleaning

If inspection indicates cleaning is needed, refer to section 4.1. Always clean before completing the remaining preventive maintenance procedures. This ensures that the sensors are clean and dry before calibration.

C. Retrieving the Event Log

Refer to the FMS Directions For Use manual for complete instructions.

1. Attach the RS-232 communications cable from the PC to the instrument COMM port.
2. Sign on to FMS. Select the Event Log command from the Main Menu, and then store the Event Log to a file.
3. View or print the event log. Inspect Event Log for watchdogs, faults or other system errors. Refer to Chapter 6, Troubleshooting, for details on interpreting the Event Log.

D. Checking Memory Backup Battery

A lithium primary cell backs up memory and powers the RTC when the instrument is turned off. This battery should be replaced every five years. The installation date is displayed on the Battery History Log page (date is in the top line on the right-hand side, refer to Appendix D).

The Battery History Log is accessed by the BATLOG softkey. The BATLOG soft-key is displayed by pressing the MoreOptions key while on the Standard Display page (software version 3.2 and higher). Refer to Repair, section 7.0, for instructions on replacing the backup battery.

NOTE: *Memory contents will be lost during replacement of the lithium backup battery, so this step should be performed after retrieving the Event Log and before calibrating the instrument.*

E. Verifying Proper Software Version, Serial Number, and Customized Settings

Verify that the software version installed in the instrument is appropriate by viewing either the Instrument Information page during power-up, or the Model 2860 I.D. page and Model 2863 Configuration pages 4 and 5 that is available when the MORE OPTIONS key is used.

Determine the serial number stored in instrument memory. This can be read from either the Instrument Information page or the I.D. page. If the serial number is not the same as the number on the rear label of the instrument, use FMS to enter the correct number (refer to FMS Manual for details).

Verify that the instrument settings which your institution has chosen to customize are configured properly. Refer to the FMS Manual.

F. Calibration

Annual calibration is recommended to account for any wear or drift in the sensor systems. These sensor systems include cassette/latch, patient-side occlusion, and fluid-side occlusion. Be sure that the sensors are clean and dry before recalibrating. Refer to Chapter Five for calibration procedures.

G. Functional Tests

Functional tests are recommended to verify that the instrument is performing within specifications. Refer to Chapter Three for detailed procedures. These functional tests include the following.

- Electrical safety
- Power-up
- Cassette/latch sensor
- Patient-side occlusion detection
- Fluid-side occlusion detection
- Air-in-line detection
- Battery operating time
- Volume accuracy
- Watchdog audio (software versions 3.3 and higher)
- Communications

H. Reprogram Special Note Page (Optional)

The optional Special Note page may be used to provide a reminder of when the next annual maintenance is due, or any other message of up to five lines of text. When this function is enabled, this page will be displayed on the date programmed. The Special Note page can also be used to program up to five lines of user text which will be displayed after the Instrument Information page, during instrument power-up. To enable this function, use FMS. Set the notification date, and enter up to five lines of text. Refer to the FMS Manual for detailed programming instructions.

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Chapter 5

Calibration

5.0 Introduction

Differences among instrument components (e.g., transducers, mechanical components, circuit gains and offsets) necessitate the calibration of certain systems. These systems detect cassette installation, latch closure, patient-side occlusions, and fluid-side occlusions.

Software functions are used to perform instrument calibrations. Calibration is required after replacing certain components as a part of preventive maintenance, or if memory contents are corrupted. Refer to chapter 6 for help in Troubleshooting calibration failures.

Refer to the appropriate Field Maintenance Software Directions For Use for calibration information for your version of FMS software.

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Chapter 6

Troubleshooting

6.0 Introduction to Troubleshooting

6.1 General Guidelines

Before beginning any troubleshooting on the MedSystem III instrument, it is recommended that service personnel review and be familiar with the following information.

1. Operation of the MedSystem III Infusion System (Refer to the MedSystem III Infusion System Directions For Use.)
2. Operation of Field Maintenance Software (Refer to the Field Maintenance Software Directions for Use (FMS DFU).)
3. The following chapters in this Technical Manual:
   - Principles of Operation (Chapter 2)
   - System Functional Tests (Chapter 3)
   - Calibration (Chapter 5)
   - Repair (Chapter 7)

Troubleshooting the MedSystem III instrument can best be accomplished by replacing questionable parts or modules with parts or modules that are known to be good. Due to the construction techniques and equipment used to manufacture the instrument, many of the parts cannot be serviced in the field and must be replaced on a modular level. The replacement parts needed during troubleshooting are listed in Appendix C. Contact your sales representative or the Customer Service Department for further information on how to obtain these parts.

> **NOTE:** *Due to potential incompatibility, it is recommended that parts not be removed from other instruments for use as replacements.*

Technical bulletins are published periodically to supplement this manual. If a problem cannot be readily resolved using this manual or the bulletins, contact the Clinical Engineering Department for further information.

6.2 Types of Problems Encountered

6.2.1 Operator Error

Potential operator errors that might be confused with hardware problems are discussed in the troubleshooting guides. These errors are generally the first possible cause listed, since verification does not require instrument disassembly.

6.2.2 Environmental Interference

The MedSystem III intrument is designed to withstand typical environmental conditions encountered during normal use, including electromagnetic interference, mechanical shock, and temperature extremes. Possible sources of electromagnetic interference include electrosurgical units, diathermy units, portable x-ray equipment, radio interference, and electrostatic discharge. Occasionally, however, a condition that exceeds instrument specifications may occur and interfere with operation. Errors are quickly detected by self-test functions, resulting in an advisory, an alarm, a fault, or a watchdog.

6.2.3 Hardware Defects

If a problem consistently repeats in the Event Log and is reproducible during testing, then it is most likely a defect in the hardware.

6.2.4 Intermittent Defects

If a problem consistently repeats in the Event Log but cannot be reproduced during testing, it is most likely an intermittent defect. Connectors can be the source of intermittent problems.

6.2.5 Troubleshooting Procedures

a. Physical Inspection

Certain defects can be determined by inspecting the instrument. Refer to diagrams in Appendix E for names of parts and layout. Inspect the items listed below prior to troubleshooting, disassembling, or repairing. Verify that the following conditions exist.

1. AC Adapter:

- AC power and ground prongs are not damaged or loose.
- Housing is intact, free of cracks, and the side of the case is not bulged or dimpled.
- Cable insulation is intact and not frayed or cut.
- Instrument connector shell is intact and pins are not damaged.

2. Pole Clamp:

- Housing is not broken or cracked.
- Instrument front-to-back indexing is firm.
- Clamp rotates properly around the bracket.
- Clutch operates and is adjusted properly.
- Rubber pads are intact.

3. Loose Parts:

- Shake the instrument to ensure there are no loose internal parts.

4. Main Housing:

- There are no significant cosmetic defects.
- Labels are intact.
- Main housing is intact and free of cracks.
- Connector dust caps are intact and free of cracks.
- Battery pack is flush with top of case and sealing gasket is not visible.
- Main housing is flush with chassis, and sealing gasket is not visible.

5. Front Panel:

- Keypad is not damaged or delaminated.
- Text on LCD is evenly aligned with keypad window (i.e., LCD is not crooked).
- LCD is free of cracks.

6. Lower Housing:

- Housing is securely attached.

- Housing is intact and free of cracks.
- Lower housing clips are intact.
- Chassis mounts are intact.

7. Mechanisms and Sensors:

   First clamp instrument to a table, remove lower housing, and rotate so that the pumping mechanisms are on top. Ensure the following conditions exist.

   - Air-in-line sensor modules are attached securely.
   - Air-in-line sensor tubing recess is thoroughly cleaned.
   - Slide links are clean and move freely.
   - Pump latch assemblies are intact and springs seated properly.
   - Pump latch assemblies open and close with a firm snap.
   - Valve actuator tips are not damaged.
   - Valve actuator seals are not damaged and are seated properly.
   - Pressure transducers are seated and their tape covers intact.

b. Power-up the Instrument

Turn on the instrument by pressing the ON key. If it does not turn on, refer to Troubleshooting Table 6-2.

> **NOTE:** *If possible, retrieve the Event Log (see step C) before performing any troubleshooting that requires PCBA replacement.*

If the instrument does turn on, record the operating parameters on a data sheet.

c. Retrieve and Examine the Event Log

The instrument stores information that is useful for troubleshooting and documenting normal operation. This includes watchdogs, faults, and other significant events encountered during operation, service, calibration, and customizing of operational parameters. Field Maintenance Software is used to retrieve, display, and print the Event Log. Refer to the FMS Manual for details on operating FMS.

d. Reproduce the Problem

If possible, simulate the operating conditions at the time the problem occurred. When the operating conditions are not known, perform the functional tests described in Chapter 3, and operate the instrument.

Suggested settings are a rate of 125 ml/h for one hour and 999 ml/h for one hour.

e. References

Use the reference guides in the following section (6.3) to determine the appropriate troubleshooting table.

6.3 Troubleshooting References

Troubleshooting tables are provided for isolating the causes of watchdogs, faults, false alarms, advisories, performance that is not within specification, and several other types of functional problems. The following list provides the table numbers and titles.

Table	Title
6-1	External Power Problems
6-2	Fails Normal Power-up
6-3	Watchdogs after Power-up
6-4	Quick Reference Watchdog List
6-5	Communications Inoperable
6-6	NiCd Battery Problems
6-7	System Faults
6-8	Calibration Problems
6-9	User Interface Problems
6-10	Cassette and Latch Sensor Problems
6-11	Encoder Faults
6-12	Drive System Errors
6-13	Air-in-line Sensor Problems
6-14	Patient-side Occlusion Detector Problems
6-15	Fluid-side Occlusion Detector Problems
6-16	Instrument Won't Shut Off

Reference lists are provided in the following sections. Event codes used in these lists are either obtained from the Event Log, using FMS, or they are displayed during power-up on the User Information Line of the Instrument Information page (see Directions For Use).

6.3.1 Watchdogs

- Event codes 0 to 255 are watchdogs. Most watchdog codes are for use in factory analyses and are not described in detail in this manual.
- For failures during power-up, refer to Table 6-2.
- For watchdogs after power-up, refer to Table 6-3.
- For general watchdog categories, refer to Table 6-4.

6.3.2 Faults

Code	Description	Reference Table
256	System error	6-7.1
257	Drug name out of range	6-9.9
258	Drug calculation error	6-9.9
259	Motion sensor error	6-11
260	Encoder error	6-11
261	Data range error	6-9.9
262	Data range error	6-9.9
263	Pressure calibration required	6-8.1
264-269	Display Module LED failure	6-9.5
270	Pressure sensor error	6-14.3
272	Cassette calibration required	6-8.1
273	Motion sensor error	6-11
274	Pump motion error (Rev. 3.2a only)	6-12.4
275	Pump does not home	6-12.5
276	Fluid-side occlusion calibration required	6-8.1
277	Pump motion hindered	6-12.6
278	Drive system error	6-12.8
279	System error (Vers. 3.2a only)	6-7.2
280	Pressure sensor error	6-14.3
281	Encoder error	6-11
282	Pump motion hindered	6-12.7

6.3.2 Faults (continued)

Code	Description	Reference Table
283	Pump motion hindered	6-12.7
286	Air sensor error	6-13.4
287	Air sensor error	6-13.4
288	Air sensor error	6-13.4
289	Encoder error	6-11
290	Encoder error	6-11
291	System error (Rev. 3.2a only)	6-7.3
292	Latch out of order	6-10.3
293	Cassette sensor error	6-10.6
294	Air sensor error	6-13.4
295	Air sensor error	6-13.4
296	Encoder error	6-11
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298	Drive system error	6-12.8
299	Drive System error	6-12.8
300	EPROM error System error	6-3
301	Timebase error System error	6-3
302	Voltage error System error	6-3
303	Voltage error System error	6-3
304	EPROM error System error	6-3
305	Voltage error System error	6-3
306	System error	6-3
307	System error	6-3
308	System error	6-3
309	System error	6-3
310	Parameter Range error	6-7.6
311	Power System Failure	6-7.5
312	Parameter Range error	6-7.6
313	System Inconsistency	6-7.6
314	System Inconsistency	6-7.6
315	System Inconsistency	6-7.6
316	System Inconsistency	6-7.6
317	System Inconsistency	6-7.6
318	System Inconsistency	6-7.6
319	System Inconsistency	6-7.6
320	System Inconsistency	6-7.6
321	System Inconsistency	6-7.6
322	System Inconsistency	6-7.6
323	System Inconsistency	6-7.6
324	System Inconsistency	6-7.6
325	System Inconsistency	6-7.6

6.3.3 Significant Events

Code	Description	Reference
514	Keypad error	Table 6-9.2
528	Communications error	Table 6-5.3
529	Initialization	Section 6.4.2
530-531	Normal use	Section 6.4.1
532	Parameters configured	Section 6.4.5
533	Initialization	Section 6.4.2
534	Power system failure	Table 6-7.4

6.3.3 Significant Events (continued)

Code	Description	Reference
536-543	Parameters configured	Section 6.4.5
553-560	Normal use	Section 6.4.1
561	Parameters configured	Section 6.4.5
568	Event Log related	Section 6.4.3
569-574	Calibration	Section 6.4.4
575	Cassette & latch calibration	Table 6-8.3
576	Cassette & latch calibration	Table 6-8.3
577	Fluid-side occlusion	Table 6-8.5
578	Fluid-side occlusion	Table 6-8.5
579	Pressure calibration	Table 6-8.2
580	Pressure calibration	Table 6-8.2
582-583	Parameters configured	Section 6.4.5
592	Software version changed	------
593	Event Log related	Section 6.4.3
594-604	Parameters configured	Section 6.4.5

6.3.4 Alarms, Advisories, and Notifications

Description	Reference
Air in line	Table 6-13
Air in lower tubing	Directions For Use
Cassette jammed	Table 6-12.3
Cassette not latched	Table 6-10.2
Cassette removed	Table 6-10.4
Check air sensor	Tables 6-13.1,2
Faulty cassette	Table 6-10.6
Fluid-side occluded	Table 6-15
Install cassette	Table 6-10.5
Patient-side occluded	Table 6-14
Pump latch closed	Table 6-10.3
Power system failure	Table 6-7.4
Push slide clamp in	Table 6-10.1

6.3.5 Performance Out of Specification

Description	Reference
Air-in-line detection	Table 6-13.3
Battery operating time	Table 6-6
Fluid-side occlusion detection	Table 6-15.2
Ground continuity	Table 6-1.3
Leakage current	Table 6-1.2
Patient-side occlusion detection	Table 6-14.1,2
Volume accuracy	Table 6-12.2

6.3.6 Other Conditions

Description	Reference
Audio	Table 6-9.3,4
Calibration out of limits	Table 6-8.2-5
Cassette installation	Table 6-12.1
Communications	Table 6-5
Fails normal power-up	Table 6-2
Instrument will not shut off	Table 6-16
Keypad	Table 6-9.1

6.3.6 Other Conditions (continued)

Description	Reference
LCD	Table 6-9.6 - 8
LED and external power	Table 6-1.1
LED (Display Module)	Table 6-9.5
Pump shutoff: low power	Directions For Use
Pump does not home (without Code 275 fault)	Table 6-11.9
Pump shutoff: not in use	Directions For Use
Pump shutoff: Watchdog demo	Directions For Use

6.4 Event Codes Recorded During Normal Use

6.4.1 Operating Events

530 Setup Line Enabled or Disabled:

If setup is enabled, then the setup line appears on the pump channel page (see Directions For Use). This feature allows the user to program an infusion, using either Volume and Rate or Volume and Time (for more information, see the Directions For Use). If setup is disabled, then only Volume/Rate infusions can be set, and the setup line does not appear on the pump channel page.

531 Device Type Changed:

This code is logged whenever the Device Type is changed. Secondary data indicates the selected Device Type.

Device Type	Secondary Data
General purpose	0
Neonatal	1
Controller pressure	2
Operating room	3
General purpose II	4
Operating room II	5

553 - 560 Time and Date Changed

Whenever the user changes the time, day, month, or year, two codes are associated with each parameter change. The first code indicates what the parameter setting was prior to the change, and the second code indicates the setting after the change.

Code	Parameter Setting
553	Time changed: previous value
554	Time changed: current value
555	Day changed: previous value
556	Day changed: current value
557	Month changed: previous value
558	Month changed: current value
559	Year changed: previous value
560	Year changed: current value

6.4.2 Initialization

529 RAM initialization:

Shorting the two pads on the top interconnect board initializes the RAM space. This is generally performed when an instrument is reassembled, or when memory is corrupted.

533 Partial RAM initialization:

Certain data structures in RAM space are initialized when faults or infusion parameters are reset using FMS. Fault resets are indicated by a secondary data value of 32, and infusion parameter (e.g., volume remaining and rate) resets by a 1.

6.4.3 Event Log Related

568 Event Log entry corrupted:

A data integrity check is performed on each Event Log entry. Should the data become corrupted, this code replaces the initial code. It is not possible to recover the particular Event Log entry when this has occurred.

593 Event Log cleared:

This code indicates the Event Log was cleared with FMS.

6.4.4 Calibration

Calibration is documented in the Event Log by the codes in the following list. Numbers 569 through 574 indicate that a calibration step was performed for a particular channel. Thus, complete calibration of an instrument will result in 18 Event Log entries.

Code	Calibration Out of Limit
575	Cassette and latch sensor, Step 1
576	Cassette and latch sensor, Step 2
577	Fluid-side occlusion, Step 1
578	Fluid-side occlusion, Step 2
579	Patient-side occlusion, calibration zero
580	Patient-side occlusion, calibration slope

6.4.5 Parameters Configured

Certain instrument functions may have been customized either by an authorized MedSystem representative or by the customer through the use of FMS. The following event codes describe what parameters are customized. Refer to the FMS Directions For Use Manual for additional information on configuring parameters. If a command is not listed, then the parameter could not be set with FMS at the time this manual was published.

Code	Parameters
532	Maximum pressure limit
536	Pressure increment
537	Maximum volume remaining
538	Maximum rate
539	KVO rate
540	Air-in-line sensitivity
541	Device Type change lockout enabled or disabled
542	High resolution rate enabled or disabled (for software versions prior to 3.1 series)
543	ALL mode enabled or disabled
561	ON/OFF key holding time to turn pump off
582	Audio volume ramping
583	MaxFSO function enabled or disabled
594	ClrAir function rate range
595	ClrAir function enabled or disabled
596	ClrAir function maximum number

Code	Parameters (Cont.)
598	Clear Secondary VR, if off >5 min
604	Fractional scrolling breakpoint

Secondary data, which is dependent on the software version in use, indicates the selected Device Type. The parameters for each Device Type must be customized separately.

Device Type	Secondary Data
General purpose	0
Neonatal	1
Controller pressure	2
Operating room	3
General purpose II	4
Operating room II	5

Table 6-1. External Power Problems

Symptom	Possible Cause and Action
1. External power LED off (see side panel).	**A. AC power not applied to the adapter** • Ensure that AC adapter is properly plugged into an AC outlet. • Verify that the wall outlet is functioning. **B. AC adapter not connected to instrument** • Ensure that AC adapter is properly connected to the instrument. **C. Defective AC adapter** • Test AC adapter with AC adapter tester. • The definitions for the LED symbols are Power: ⎓ Ground: ⏚ Grounded Shield: ⊜ • Verify that all LEDs are illuminated. • If any LEDs are not illuminated, AC adapter is defective and must be replaced. If LEDs are illuminated, proceed to next step. • Verify that output signal on oscilloscope is within the range of 6 to 10 VDC with a maximum ripple voltage of 1.5 Vp-p. • If voltage is out of range, AC adapter is defective and must be replaced. **D. Defective audio/connector PCBA** • Ensure that connectors to power supply for MA are properly seated. • Test with a replacement audio/connector PCBA. • If problem does not repeat, replace suspect PCBA. **E. Defective power supply PCBA** • Disconnect the power supply connector for the audio/connector PCBA. If external power LED turns on, power supply PCBA is defective. **F. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
2. Leakage current greater than 100 µA.	**A. Incorrect leakage current test procedure** • Refer to the test equipment manual for proper procedure. **B. Defective AC adapter** • Replace AC adapter.
3. Ground continuity greater than 0.1 ohms.	NOTE: To minimize contact and lead resistances, measure the following resistances with a four-wire ohmmeter. **A. Black-coated chassis** • The black coating is an insulator. Measure ground continuity from the bare metal test point located toward the rear of the instrument underneath the lower housing (see Chapter Three). **B. Aluminimum chassis** • The test point can be any location.

(Table continued next page)

Table 6-1. *External Power Problems (Cont.)*

3. Ground continuity greater than 0.1 ohms. (continued)	**C. AC adapter connector grounding defective** • With the AC adapter attached to the MedSystem III, measure resistance from connector body to AC adapter ground pin. • If greater than 0.1 ohms, replace AC adapter. **D. Audio/Connector PCBA grounding defective** • Measure resistance from A/C nut to-AC adapter ground pin. • If greater than 0.1 ohms, replace audio/connector PCBA. **E. Defective connection on the chassis** • Remove screw holding green ground wire to the chassis. • Clean surface and lug terminal. • Reinstall lug and screw. **F. Defective connection on power supply PCBA.** • Replace power supply PCBA when the above procedures fail to indicate the source of the problem.

Table 6-2. *Fails Normal Power-up*

Symptom	Possible Cause and Action
1. Totally unresponsive (no audio, LEDs, LCD).	**A. Fuse blown and no external power** • Attach AC adapter power and charge the battery for 1 hour. • Turn instrument on. • Remove external power. • If instrument turns off, the fuse is blown. • Replace fuse. **B. Battery voltage low and no external power** • Attach AC adapter power and verify external power LED is ON. If not, refer to Table 6-1. • If on, charge battery for 1 hour and retry. • Try again to turn on the instrument. • If instrument turns on normally, then charge for 13 hours. **C. Defective internal connection** • Reseat top interconnect board, keypad, power board and audio/connector PCBA connectors. **D. Defective battery** • Replace suspect battery with a replacement battery. • Charge for 1 hour. If instrument turns on, replace suspect battery. **E. Defective keypad** • Remove main housing and test with replacement case. • Replace case if defective. **F. Defective power supply PCBA** • Test with a replacement power supply PCBA. If instrument turns on normally, suspect power supply is defective and must be replaced. **G. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
2. Watchdog occurs during power-up.	**A. Battery depleted and no external power** • Attach AC adapter power and verify external power LED is on. If not, refer to Table 6-1. • If on, charge battery for 1 hour. • Try again to turn on instrument. • If instrument turns on normally, charge battery for 13 hours. **B. Fuse blown and no external power** • Attach AC adapter power and charge the battery for 1 hour. • Turn on instrument and remove external power. • If instrument turns off, the fuse is blown. • Replace fuse. **C. Event Code 40: Pump latch moved during motor path self-test on power-up** • Verify by repeating ON/OFF sequence several times with no cassette in place. • If Event Code 40 repeats, replace MEA. • If Event Code 40 does not repeat, it is likely that the pump latch was moved manually during self-test. **D. Event Code 30: Range error** • Use FMS to reset infusion parameters. • If this event code repeats, initialize RAM by jumpering the RAM initialization solder pads. Refer to Chapter 7.

(Table continued next page)

Table 6-2. *Fails Normal Power-up (Cont.)*

2. Watchdog occurs during power-up. (continued)	**E. EPROM missing, inserted improperly, or defective** • Remove battery pack and inspect EPROM. • Reseat if not properly installed. • Replace if properly installed and still fails to operate. **F. Top interconnect board not seated** • Reseat top interconnect board. **G. Power supply connector not seated** • Reseat four-wire connector from power supply to audio/connector PCBA. **H. Defective power supply PCBA** • Test with a replacement power supply PCBA. If instrument turns on normally, suspect power supply is defective and must be replaced. **I. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
3. LEDs and audio work, but no LCD message.	**A. Top board interconnect not seated.** • Remove battery pack and reseat top interconnect board. **B. Defective LCD** • Test with replacement LCD module. • Replace LCD module if defective. **C. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

Table 6-3. Watchdogs After Powerup

Symptom	Possible Cause and Action
1. Any Watchdog code (isolated occurrences).	**A. System error discovered after publication of this manual.** • Review Technical Service Bulletins, or contact the Technical Service Dept. for the latest information. **B. Top interconnect board not seated** • Remove battery pack and reseat top interconnect board. **C. Fuse blown and no external power** • Attach AC adapter power and charge the battery for 1 hour. • Turn on instrument. • Remove external power. • If instrument turns off, the fuse is blown. • Replace fuse. **D. Environmental interference** • Refer to section 6.1.2.
2. Event Code 51	**A. Pump latch moved while instrument is not infusing** • Turn on instrument and check for movement. • If no movement occurs, the latch may have been moved manually. • If movement occurs, replace MEA.
3. Event Codes 21, 25, 26, 27 300*, 304*	**A. Defective EPROM** • Replace EPROM module.
4. Repeated occurrences of any Watchdog.	**A. System error discovered after publication of this manual** • Review Technical Service Bulletins, or contact the Technical Service Dept. for the latest information. **B. Top interconnect board not seated** • Remove battery pack and reseat top interconnect board. **C. Fuse blown and no external power** • Attach AC adapter power and charge the battery for 1 hour. • Turn on instrument. • Remove external power. • If instrument turns off, the fuse is blown. • Replace fuse. **D. Defective power supply PCBA** • Test with a replacement power supply PCBA. If instrument turns on normally, suspect power supply is defective and must be replaced. **E. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

* These codes are not watchdogs; they are non-resumable faults caused by the occurrence of a particular watchdog.

Table 6-4. Quick Reference Watchdog List

Symptom	Possible Cause and Action
30	**Data Handling** • Cycle power to reset pump. If WD continues, return pump to IVAC.
72, 95, 96	**Air-in-line** • Cycle power. If WD continues, return pump to IVAC.
94	• Replace MEA board.
49	**Encoder** • Cycle power. If WD continues, return pump to IVAC.
16, 35 (Rev. 3.3d only)	**Infusion Control** • Cycle power to reset pump. If WD continues, return pump to IVAC.
17, 39, 56	**Motor** • Cycle power to reset pump. If WD continues, return pump to IVAC.
40	• Replace drive module.
47, 48 (Rev. 3.3d only), 67 302*, 303*, 309*	• Replace power board.
51, 98 306*	• Replace MEA board.
88 305*	• Replace power board or MEA board.
101 307*	**13V Power Supply Voltage is Greater than 13V** • Substitute known good MEA board. If this does not fix problem, replace power board.
102 308*	**5V Power Supply Voltage is Greater than 5V** • Substitute known good MEA board. If this does not fix problem, replace power board.
75, 77, 79, 80, 81, 82, 85, 89, 90, 91, 97, 99, 100	**Power On Self-Test** • Replace MEA board.
83, 86	• Replace power board.
87	• Replace power board or MEA board.
22, 23, 42, 43, 44, 46	**Watchdog Control** • Cycle power. If WD continues, return pump to IVAC.
45, 84	• Replace MEA board.
6, 9, 10, 41, 50, 58, 59	**System Task** • Cycle power. If WD continues, return pump to IVAC.
24, 37 301*	**Timing** • Replace MEA board.

(Table continued next page)

Table 6-4. Quick Reference Watchdog List (Cont.)

0, 1, 2, 7, 33, 52	**General System** - Cycle power. If WD continues, return pump to IVAC.
70, 73 304*	- Replace EPROM.
4	**A-to-D** - Cycle power. If WD continues, return pump to IVAC.
5	- Replace MEA board.
8, 11, 12, 13, 14, 15, 32, 34, 60, 61, 62, 63, 64, 65, 66, 68, 78	**Hardware** - Replace MEA board.
21, 25, 26, 27	- Replace EPROM.
31	- Cycle power. If WD continues, return pump to IVAC.
57	**Defective Keypad** - Replace Main Housing. If problem repeats, replace MEA board.
18, 19, 28, 38	**Miscellaneous** - Cycle power. If WD continues, return pump to IVAC.
92, 93	- No problem. Information in event log only.

* These codes are not watchdogs; they are non-resumable faults caused by the occurrence of a particular watchdog.

Table 6-5. Communications Inoperable

Symptom	Possible Cause and Action
1. The FMS does not communicate with any MedSystem III instrument.	**A. Cables not connected** • Ensure PC cable connectors are properly seated. **B. The FMS not configured for present communications port in the PC** • Refer to the FMS Instructions. **C. Pump not in Clinical Configuration Mode** • Refer to the FMS and the Directions For Use. **D. Communications cable defective** • Retry with a replacement cable. **E. Defective serial port for the FMS computer** • Retry with a replacement serial card.
2. The FMS does not communicate with a specified MedSystem III instrument.	**A. Audio/connector PCBA connector not seated** • Reseat ribbon cable connector to MEA. **B. Defective audio/connector PCBA.** • Ensure that connectors to power supply for MEA are properly seated. • Test with a replacement A/C PCBA. • If problem does not repeat, replace suspect PCBA. **C. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
3. Event code 528	**A. System error** • This code indicates that an internal error occurred during communications. Contact the Clinical Engineering Department for further information.

Table 6-6. NiCd Battery Problems

NOTE: Before troubleshooting, perform a complete battery performance test (see Chapter 3).

- T_{LB1} is the time interval from full charge to low-battery advisory.
- T_{LB2} is the time interval from low-battery advisory to battery-depleted alarm.
- T_{total} is the sum of T_{LB1} and T_{LB2}.

Symptom	Possible Cause and Action
1. Sufficient capacity (T_{total}>6h) but premature low-battery advisory (T_{LB1} <5.5h).	A. **Storage at extremes of temperature specifications** • Storage at elevated temperatures between 35°C and 55°C can degrade performance. If the exposure time is for under a week, some recovery is possible, but only after several complete charge/discharge cycles at room temperature. (Operate instrument past battery-depleted to shut off, then recharge for 14 hours.) Storage for more than 3 months should be at temperatures below 35°C; otherwise, permanent damage can occur. B. **Operation at extremes of temperature specifications** • NiCd battery capacity is maximum at room temperature and is significantly reduced at temperatures above 35°C. Exposure to high temperatures for a short time will not cause permanent damage; and, capacity will recover after several complete charge/discharge cycles at room temperature. (Operate instrument past battery depleted to shut off, then recharge for 14 hours.) C. **Battery voltage depression effect** • Repeated shallow discharge or extended AC charging of NiCd batteries can cause a temporary depression in the voltage discharge characteristics. Several complete charge/discharge cycles reverse this condition. (Operate instrument past battery depleted to shut off, then recharge for 14 hours.) D. **Defective battery** • Test with a charged replacement battery and repeat battery operating advisory test. • If problem does not repeat, then the suspect battery is defective and must be replaced. E. **Defective power supply PCBA** • Test with a charged replacement battery. F. **Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

(Table continued next page)

Table 6-6. NiCd Battery Problems (Cont.)

2. Inadequate Capacity (T_{total} <6h).	**A. Battery not charged due to external power problem** • Refer to Table 6-1. **B. Storage at extremes of temperature specifications** • Storage at elevated temperatures between 35°C and 50°C can degrade performance. If the exposure time is for under a week, some recovery is possible, but only after several complete charge/discharge cycles at room temperature. (Operate instrument past battery-depleted to shut it off, then recharge for 14 hours.) Storage for more than 3 months should be at temperatures below 35°C; otherwise, permanent damage can occur. **C. Operation at extremes of temperature specifications** • NiCd battery capacity is maximum at room temperature and is significantly reduced at temperatures above 35°C. Exposure to high temperatures for a short time will not cause permanent damage; and, capacity will recover after several complete charge/discharge cycles at room temperature. (Operate instrument past battery-depleted to shut it off, then recharge for 14 hours.) **D. Defective battery** • Test with a charged replacement battery and repeat battery operating-time test. • If problem does not repeat, suspect battery is defective and must be replaced. **E. Defective power supply PCBA** • Test with replacement power supply PCBA. • If problem does not repeat, suspect battery is defective and must be replaced. **F. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

Table 6-7. System Faults

Symptom	Possible Cause and Action
1. Event code 256: System error.	**A. Defective watchdog circuit** • If problem repeats, replace MEA.
2. Event code 279: System error (Software version 3.2a only).	**A. Corrupted RAM contents** • Reinitialize RAM by jumpering RAM initialization solder pads. Refer to Chapter 7. **B. Defective memory circuit** • If problem repeats, replace MEA.
3. Event code 291: System error (Software version 3.2a only).	**A. Internal date corrupted** • Software indicates that data is corrupted. If you suspect that the corruption was not due to environmental interference, contact the Clinical Engineering Department.
4. Event code 534: Internal Charger fault.	**A. Defective battery** • Test with a replacement battery. • Charge for 1 hour with instrument off. • With AC power attached, turn the instrument on and operate overnight (at least 10 hours) with a cassette in at least one channel. The channel with the cassette does not need to be infusing, but should be placed on STANDBY. • If problem does not repeat, suspect battery is defective and must be replaced. **B. Defective power supply PCBA** • Test with replacement power supply PCBA. • Charge for 1 hour with instrument off. • With AC power attached, turn the instrument on and operate overnight (at least 10 hours) with a cassette in at least one channel. The channel with the cassette does not need to be infusing, but should be put on STANDBY. • If problem does not repeat, suspect power supply is defective and must be replaced. **C. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

(Table continued next page)

Table 6-7. *System Faults (Cont.)*

5. Event code 311: Power system failure.	**A. Defective battery** • Test with a replacement battery. • Charge for 1 hour with instrument off. • With AC power attached, turn the instrument on and operate overnight (at least 10 hours) with a cassette in at least one channel. The channel with the cassette does not need to be infusing, but should be placed on STANDBY. • If problem does not repeat, suspect battery is defective and must be replaced. **B. Defective power supply PCBA** • Test with replacement power supply PCBA. • Charge for 1 hour with instrument off. • With AC power attached, turn the instrument on and operate overnight (at least 10 hours) with a cassette in at least one channel. The channel with the cassette does not need to be infusing, but should be put on STANDBY. • If problem does not repeat, suspect power supply is defective and must be replaced.
6. Event Codes 310, 312 - 325	**A. General System Error** • If pressing RETRY does not solve the problem or if the error is occurring repeatedly, contact the Clinical Engineering Department for further information.

Table 6-8. Calibration Problems

Symptom	Possible Cause and Action
1. Event code 263: Pressure calibration required. Event code 272: Cassette and latch sensor calibration required. Event code 276: Fluid-side occlusion detection calibration required.	**A. Calibration not performed (software versions prior to 3.2)** • Recalibrate the instrument, using FMS (refer to Chapter 5). **B. Calibration not performed correctly (software version 3.2 and above)** • Recalibrate the instrument, using FMS (refer to Chapter 5). **C. Backup battery not connected or depleted** • Measure Vback at backup battery connector. • If less than 2.5V, replace battery. **D. Defective memory backup circuits on MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
2. Event codes 579 & 580: Pressure calibration (zero or slope) not within limits.	**A. Calibration not performed correctly** • Recalibrate the instrument, using FMS. • Ensure that proper pressure is applied (refer to Chapter 5). **B. Pressure connector loose** • Remove main housing and LCD. • Reseat pressure transducer connector. **C. Defective pressure transducer** • Inspect for broken wires. Replace transducer if wires are broken. • Using the pressure transducer jumper cable, connect the suspect transducer to a channel that operates properly. Recalibrate the replacement channel; but, apply pressure to the suspect transducer. If the problem recurs, replace the suspect transducer. **D. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
3. Event codes 575 & 576: Cassette and latch calibration.	**A. Calibration not performed correctly** • Recalibrate the instrument, using FMS. Ensure that cassettes are installed at the proper step and that the pump latch is in the proper position. **B. Cassette or latch sensor dirty** • Clean optomodule sensors and slide link, using procedure described in Chapter 4. • Remove slide link, using procedures described in Chapter 7. • Inspect slide link reflector and replace if damaged. **C. Optomodule flex not seated in connector properly** • Reseat both flex cables. • Ensure that the two flex cables are properly positioned. **D. Defective optomodule** • Measure input and output of the optomodule sensors, as described in Figures 6-1 and 6-2. • If input signals are correct but output signals are incorrect, then replace the optomodule. **E. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

(Table continued next page)

Table 6-8. Calibration Problems (Cont.)

Symptom	Possible Cause and Action
4. Fluid-side occlusion calibration will not run or complete.	**A. Cassette and latch sensors must be calibrated first** • Repeat cassette and latch calibration, using FMS. **B. Defective calibration cassettes** • Check operation of piston. • A piston sleeve must not be used with this cassette. • Elastomeric valve area in the cassette must be removed. • Replace cassette if defective, and repeat calibration. **C. Defective calibration fixture** • Check calibration fixture function, using the procedure accompanying the fixture. **D. Mechanical interference from latching mechanism** • Remove the lower housing. • Remove a piston from a cassette. Place cassette piston in pump latch and close the latch. • Verify that the pump latch does not bind with the side link. If it does, replace the pump latch or the slide link. **E. Motor and encoder connectors not seated** • Reseat connectors. **F. Defective drive module or motor** • Remove a piston from a cassette. • Put the piston in the pump latch and close the latch. • Verify that the pump latch does not bind with the slide link. • Rotate affected drive cam manually, being careful not to get grease on the belt. • If cam does not rotate smoothly, remove the drive belt. • If isolated cam does not rotate, replace the drive module. • Connect motor to a 5V power supply (red wire to positive), and verify that drive runs smoothly. • If motor does not operate, then replace. **G. Mechanical interference from the pump shaft** • Ensure that pump shaft bearings are properly seated. • Install a bearing clip, if missing. • Remove drive module and ensure that pump shaft moves smoothly. Clean and lubricate if necessary. **H. Mechanical interference from the valve actuators** • Remove drive module. • Verify that valve actuators move smoothly. • Verify that valve actuator springs are seated properly. • Check actuator bearings for smooth operation. • Replace defective components if necessary. **I. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

(Table continued next page)

Table 6-8. Calibration Problems (Cont.)

Symptom	Possible Cause and Action
5. Event codes 577 & 578: Fluid-side occlusion calibration out of limits.	**A. Weights not applied in proper sequence** • Repeat calibration, using FMS. • Ensure weight fixture is vertical and weights are applied only when directed. **B. Defective calibration cassettes** • Check operation of piston. • A piston sleeve must not be used with this cassette. • Elastomeric valve area in the cassette must be removed. • Replace cassette, if defective, and repeat calibration. **C. Mechanical interference from latching mechanism** • Remove the lower housing. • Remove a piston from a cassette. Place cassette piston in pump latch and close the latch. • Verify that the pump latch does not bind with slide link. If it does, replace the pump latch or slide link. **D. Defective drive module or motor** • Remove a piston from a cassette. • Put the piston in the pump latch and close the latch. • Verify that the pump latch does not bind with the slide link. • Rotate affected drive cam manually, being careful not to get grease on the belt. • If cam does not rotate smoothly, remove the drive belt. • If isolated cam does not rotate, replace the drive module. • Connect motor to a 5V power supply (red wire to positive), and verify that drive runs smoothly. • If motor does not operate, it must be replaced. **E. Mechanical interference from the pump shaft** • Ensure that pump shaft bearings are properly seated. • Install a bearing clip, if missing. • Remove drive module and ensure that pump shaft moves smoothly. Clean and lubricate, if necessary. **F. Mechanical interference from the valve actuators** • Remove drive module. • Verify that valve actuators move smoothly. • Verify that valve actuator springs are seated properly. • Check actuator bearings for smooth operation. • Replace defective components if necessary. **G. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

Table 6-9. User Interface Problems

Symptom	Possible Cause and Action
1. Keypad does not respond.	**A. Keypad connector not seated** • Reseat connector. **B. Defective keypad** • Remove main housing. • Test with replacement keypad; if needed, replace keypad. **C. Defective audio/connector PCBA** • Disconnect audio/connector PCBA ribbon cable attached to the MEA and retry. • If problem does not repeat, replace audio/connector PCBA. **D. Defective decoder circuit on MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
2. Event code 514: Keypad system error.	**A. Defective keypad** • Remove main housing. • Test with replacement keypad; if needed, replace keypad. **B. Defective audio/connector PCBA** • Disconnect audio/connector PCBA ribbon cable attached to the MEA and retry. • If problem does not repeat, replace audio/connector PCBA. **C. Defective decoder circuit on MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
3. No audio output.	**A. Audio/connector PCBA ribbon cable connector not seated** • Remove battery pack. • Reseat ribbon cable connector to MEA. **B. Defective audio/connector PCBA** • Test with replacement audio/connector PCBA. **C. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
4. No watchdog audio, but other audio tones all right.	**A. Defective MEA** • Replace MEA.
5. Event codes 264 - 269: Display module LED failure (green or red) or Display module LEDs do not turn on.	**A. Top interconnect board not seated** • Remove battery pack. • Reseat top interconnect board. **B. Defective display module** • Test with replacement display module. If needed, replace display module. **C. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem. (Table continued next page)

Table 6-9. User Interface Problems (Cont.)

Symptom	Possible Cause and Action
6. LCD is missing pixels.	**A. Defective display module** • Test with a replacement display module. If needed, replace display module.
7. LCD contrast is incorrect.	**A. Contrast not adjusted optimally** • Use the CNTRST softkey (VIEW in Model 2860) to adjust the display contrast (refer to Directions For Use). **B. Extreme temperature effects** • Allow instrument to equilibrate to room temperature. **C. Defective Keypad** • Test with replacement case. If needed, replace case. **D. Defective display module** • Test with a replacement display module. If needed, replace display module. **E. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
WARNING: *Potential shock hazard with the backlighting.*	
8. Backlighting is out.	**A. Backlighting timed out** • Apply external power by attaching AC adapter. • Press STANDARD DISPLAY key and verify backlighting is on. • See Directions For Use for detailed instructions on backlight time out. **B. Backlight panel cable not connected** • Remove main housing and ensure backlight panel connector from power supply PCBA is properly seated. **C. Defective backlight panel** • Test suspect display module with a replacement display module. • If problem does not repeat, replace the backlight panel on the suspect display module. **D. Defective power supply module** • Test with a replacement power supply. • If problem does not repeat, suspect power supply is defective and must be replaced. **E. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
9. Event codes 261 & 262: Data range error. Event codes 257 & 258.	A. **Rate, volume, time combination out of command range** • Normally this can be resumed by the operator. • If the channel displays BIOMED in the Model 2860 or SERVICE in the Model 2863, use FMS to reset faults and initialize parameters. If the problem recurs, contact the Clinical Engineering Department.

Table 6-10. Cassette and Latch Sensor Problems

Symptom	Possible Cause and Action
1. *Push Slide Clamp In* advisory when START is pressed.	**A. Cassette slide clamp not pushed in all the way** • See Directions For Use for proper procedure. **B. Dirt in optomodule or slide link sensing area** • Clean optomodule, using procedure in Chapter 4. **C. Calibration not performed correctly** • Recalibrate the instrument, using FMS. Ensure that cassettes are installed at the proper step, and that the pump latch is in the proper position. **D. Damaged slide link reflector** • Remove slide link, using procedure described in Chapter 7. • Inspect reflector and replace if damaged. **E. Optomodule flex not seated** • Remove main housing and expose optomodule flex connectors. • Inspect and reseat flex. Ensure that the flexes are centered properly. **F. Defective Optomodule** • Measure input and output of the optomodule sensors, as described in Figures 6-1 and 6-2. **G. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
2. *Cassette Not Latched* alarm.	**A. Cassette slide clamp not pushed in all the way** • See Directions For Use for proper procedure. **B. Dirt in optomodule or slide link sensing area** • Clean optomodule, using procedure in Chapter 4. **C. Calibration not performed correctly** • Recalibrate the instrument, using FMS. Ensure that cassettes are installed at the proper step, and that the pump latch is in the proper position. **D. Damaged slide link reflector** • Remove slide link, using procedure described in Chapter 7. • Inspect reflector and replace if damaged. **E. Optomodule flex not seated** • Remove main housing and expose optomodule flex connectors. • Inspect and reseat flex. Ensure that the flexes are centered properly. **F. Defective Optomodule** • Measure input and output of the optomodule sensors, as described in Figures 6-1 and 6-2. **G. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

(Table continued next page)

Table 6-10. *Cassette and Latch Sensor Problems (Cont.)*

Symptom	Possible Cause and Action
3. Event code 292: Pump latch out of order or *Pump Latch Closed* alarm.	**A. Latch closed accidentally during cassette installation or removal** • If Biomed key was pressed, this results in Fault Code 292. • Manually open the pump latch. • Reset the fault, using FMS. • Perform cassette functional tests (see Chapter 3). **B. Dirt in optomodule or slide link sensing area** • Clean using procedures described in Chapter 4. **C. Cassette I.D. optics defective, dirty or wet** • Test with replacement cassette. • If problem does not repeat, the cassette optics may have been defective, dirty or wet. • Return defective cassettes to the Technical Service Dept. **D. Calibration not performed correctly** • Recalibrate the instrument, using FMS. Ensure that cassettes are installed at the proper step, and that the pump latch is in the proper position. **E. Defective Latching Mechanism** • Remove lower housing. • Inspect slide link and pump latch for proper operation. **F. Damaged slide link reflector** • Remove slide link, using the procedure described in Chapter 7. • Inspect reflector and replace if damaged. **G. Optomodule flex not seated** • Remove main housing and expose the optomodule flex connectors. • Inspect and reseat flex. Ensure that the flexes are centered properly. **H. Defective Optomodule** • Measure input and output of the optomodule sensors, as described in Figures 6-1 and 6-2. • If input signals are correct but output signals are incorrect, replace the optomodule. **I. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem. (Table continued next page)

Table 6-10. *Cassette and Latch Sensor Problems (Cont.)*

Symptom	Possible Cause and Action
4. *Cassette Removed* alarm.	**A. Dirt in optomodule or slide link sensing area** • Clean optomodule, using procedures described in Chapter 4. **B. Cassette I.D. optics defective, dirty or wet** • Test with replacement cassette. • If problem does not repeat, the cassette optics may have been defective, dirty or wet. • Return defective cassettes to the Clinical Engineering Department. **C. Calibration not performed correctly** • Recalibrate the instrument, using FMS. Ensure that cassettes are installed at the proper step, and that the pump latch is in the proper position. **D. Damaged slide link reflector** • Remove slide link, using procedure described in Chapter 7. • Inspect reflector and replace if damaged. **E. Optomodule flex not seated** • Remove main housing and expose the optomodule flex connectors. • Inspect and reseat flex. Ensure that the flexes are centered properly. **F. Defective Optomodule** • Measure input and output of the optomodule sensors, as described in Figures 6-1 and 6-2. • If input signals are correct but output signals are incorrect, replace the optomodule. **F. Defective Optomodule** • Measure input and output of the optomodule sensors, as described in Figures 6-1 and 6-2. • If input signals are correct but output signals are incorrect, replace the optomodule. **G. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

(Table continued next page)

Table 6-10. *Cassette and Latch Sensor Problems (Cont.)*

Symptom	Possible Cause and Action
5. *Install Cassette* advisory when START is pressed.	**A. Dirt in optomodule or slide link sensing area** • Clean using procedures described in Chapter 4. **B. Cassette I.D. optics defective, dirty or wet** • Test with replacement cassette. • If problem does not repeat, the cassette optics may have been defective, dirty or wet. • Return defective cassettes to the Clinical Engineering Department. **C. Calibration not performed correctly** • Recalibrate the instrument, using FMS. Ensure that cassettes are installed at the proper step, and that the pump latch is in the proper position. **D. Damaged slide link reflector** • Remove slide link, using procedure described in Chapter 7. • Inspect reflector and replace, if damaged. **E. Optomodule flex not seated** • Remove main housing and expose the optomodule flex connectors. • Inspect and reseat flex. Ensure that the flexes are centered properly. **F. Defective Optomodule** • Measure input and output of the optomodule sensors, as described in Figures 6-1 and 6-2. • If input signals are correct but output signals are incorrect, replace the optomodule. **G. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
6. Event code 293: Cassette sensor error or *Faulty Cassette* alarm.	**A. Dirt in optomodule or slide link sensing area** • Clean optomodule sensors, using procedures described in Chapter 4. **B. Cassette ID optics defective, dirty or wet** • Test with replacement cassette. • If problem does not repeat, the cassette optics may have been defective, dirty or wet. • Return defective cassettes to the Clinical Engineering Dept. **C. Calibration not performed correctly** • Recalibrate the instrument, using FMS. Ensure that cassettes are installed at the proper step, and that the pump latch is in the proper position. **D. Optomodule flex not seated** • Remove main housing and expose the optomodule flex connectors. Inspect and reseat flex. Ensure that the flexes are centered properly. **E. Defective optomodule** • Measure input and output of the optomodule, as described in Figures 6-1 and 6-2. • If input signals are correct but output signals are incorrect, replace the optomodule. **F. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

Table 6-11. Encoder Faults

Symptom	Possible Cause and Action
1. Event codes 259, 260, 273, 281, 289, 290 and 296: Encoder or motion sensor error.	**A. Particles on the encoder disc or encoder sensor** • Remove battery pack, main housing and display module. • Remove cover from affected encoder. • Using clean, dry compressed air, blow disc and sensors clean. **B. Encoder connector loose** • Reseat connector. **C. Defective drive module clutch (Code 260 only)** • With display module removed, rotate drive cam to ensure that motion occurs only in one direction. • If motion occurs in both directions, replace drive module. **D. Defective drive module encoder** • Install primed cassette in affected channel • Attach display module to extender cable. • Attach test keypad and audio/connector PCBA. • Connect replacement test drive module by attaching jumper cables to suspect encoder. • Operate at the rate that the problem occurred, or 999 ml/h. • If problem does not repeat, replace the suspect drive module. **E. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

Table 6-12. Drive System Errors

Symptom	Possible Cause and Action
1. Cannot install cassette.	**A. Pump latch not in home position** • Turn instrument off, then on. Verify that the pump latch moves to the home position (position closest to the chassis). • If instrument does not home, refer to Symptom 9 of this table. **B. Pump latch unable to open due to dried solution in slide link or pump latch area** • Use cleaning procedures described in Chapter 4. **C. Mechanical damage** • Check that the pump latch opens and closes properly. • Check for loose cassette guide or air-in-line sensor module. • Replace any damaged components.
2. Volume accuracy performance out of specification.	**A. Test method error** • Refer to Chapter 3 for proper test method. • Ensure that the glassware has sufficient precision. • Verify that timing during test is performed accurately. • Ensure that setup is free of air bubbles. **B. Cassette used beyond specification** • Replace cassettes every 48 hours. **C. Pump latch height not within specification** • Verify latch height, using procedures described in Chapter 7. **D. Valve actuator springs** • Disassemble instrument to expose valve actuators. • Verify valve actuators move smoothly. • Verify springs are properly positioned and free of grease. • Replace actuators and springs if defective. **E. Valve actuator height not within specification** • Verify valve actuator height, using procedures described in Chapter 7. • Replace drive module and valve actuators if not within specification.
3. *Cassette Jammed* alarm.	Remove cassette and turn power off, then on. If the drive homes properly, then use the following procedure; otherwise, follow the guide for Error Code 275, "Pump Does Not Home" (Symptom 5 of this table). **A. Cassette piston sleeve lifted** • Remove the cassette and reseat the piston sleeve. **B. Mechanical interference from latching mechanism** • Remove the lower housing. • Remove a piston from a cassette. Place cassette piston in pump latch and close the latch. • Verify that pump latch does not bind with the slide link. **C. Pump latch height not within specification** • Verify latch height, using procedures described in Chapter 7.

(Table continued next page)

Table 6-12. *Drive System Errors (Cont.)*

Symptom	Possible Cause and Action
3. *Cassette Jammed* alarm (continued).	**D. Defective drive module encoder** • Install primed cassette in affected channel. • Attach display module to extender cable. • Attach test keypad and audio/connector PCBA. • Connect replacement test drive module by attaching jumper cables to suspect encoder. • Operate at rate the problem occurred, or 999 ml/h. • If problem does not repeat, replace the suspected drive module. **E. Defective drive module mechanism or motor** • Remove a piston from a cassette. • Put the piston in the pump latch and close the latch. • Verify that the pump latch does not bind with the slide link. • Rotate affected drive cam manually, being careful not to get grease on the belt. • If cam does not rotate smoothly, remove the drive belt. • If isolated cam does not rotate, replace the drive module. • Connect motor to a 5V power supply (red wire to positive) and verify that the drive runs smoothly. • If motor does not operate, it must be replaced. **F. Mechanical interference from the pump shaft** • Clean and lubricate if necessary. • Ensure that pump shaft bearings are properly seated. • Install a bearing clip, if missing. • Remove drive module and ensure that pump shaft moves smoothly. **G. Mechanical interference from the valve actuators** • Remove drive module. • Verify that valve actuators move smoothly. • Verify that valve actuator springs are seated properly. • Check actuator bearings for smooth operation. • Replace defective components if necessary. **H. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
4. Event code 274: Pump motion error.	**A. Defective MEA** • Replace MEA.
5. Event code 275: Pump does not home.	**A. Intentional demonstration of faults by operator** • Reset and retry. **B. Mechanical interference from latching mechanism** • Remove the lower housing. • Remove a piston from a cassette. Place cassette piston in pump latch and close the latch. • Verify that pump latch does not bind with the slide link. **C. Motor or encoder connector loose** • Remove battery pack, main housing and display module. • Reseat motor and encoder connectors. **D. Particles on encoder disc or encoder sensor** • Remove cover from affected encoder. • Using clean, dry compressed air, blow disc and sensors clean.

(Table continued next page)

Table 6-12. Drive System Errors (Cont.)

Symptom	Possible Cause and Action
5. Event code 275: Pump does not home (continued).	**E. Mechanical interference from the pump shaft** • Ensure that pump shaft bearings are properly seated. • Clean and lubricate if necessary. • Install a bearing clip, if missing • Remove drive module and ensure that pump shaft moves smoothly. **F. Defective drive module encoder** • Install primed cassette in affected channel. • Attach display module to extender cable. • Attach test keypad and audio/connector PCBA. • Connect replacement test drive module by attaching jumper cables to suspect encoder. • Operate at rate the problem occurred, or 999 ml/h. • If problem does not repeat, replace the suspected drive module. **G. Defective drive module or motor** • Remove a piston from a cassette. • Put the piston in the pump latch and close the latch. • Verify that the pump latch does not bind with the slide link. • Rotate affected drive cam manually, being careful not to get grease on the belt. • If cam does not rotate smoothly, remove the drive belt. • If isolated cam does not rotate, replace drive module. • Connect motor to a 5V power supply (red wire to positive) and verify that drive runs smoothly. • If motor does not operate, it must be replaced. **H. Mechanical interference from valve actuators** • Remove drive module. • Verify that valve actuators move smoothly. • Verify that valve actuator springs are seated properly. • Check actuator bearings for smooth operation. • Replace defective components, if necessary. **I. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
6. Event code 277: Pump motion hindered.	**A. Cassette piston sleeve lifted** • Remove the cassette and reseat the piston sleeve. **B. Cassette defective** • If possible, inspect cassette to ensure that piston moves freely. **C. Mechanical interference from latching mechanism** • Remove the lower housing. • Remove a piston from a cassette. Place cassette piston in pump latch and close the latch. • Verify that pump latch does not bind with the slide link. **D. Motor or encoder connector loose** • Remove battery pack, main housing and display module. • Reseat motor and encoder connectors.

(Table continued next page)

Table 6-12. Drive System Errors (Cont.)

Symptom	Possible Cause and Action
6. Event code 277: Pump motion hindered (continued).	**E. Drive belt slipping** • Inspect drive belt and pulleys to ensure they are free from lubricant. Replace if contaminated. • With display module attached via the extender cable, operate instrument with a fluid-filled cassette. Apply load by pinching off outlet tubing. Inspect for slippage under this load. If the belt slips, clean cam and replace belt. **F. Defective drive module encoder** • Install primed cassette in affected channel • Attach display module to extender cable. • Attach test keypad and audio/connector PCBA. **G. Defective power supply PCBA** • Test with replacement power supply PCBA. • If problem does not repeat, replace suspect PCBA. **H. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem. **I. Defective drive module mechanism or motor** • Remove a piston from a cassette. • Put the piston in the pump latch and close the latch. • Verify that the pump latch does not bind with the slide link. • Rotate affected drive cam manually, being careful not to get grease on the belt. • If cam does not rotate smoothly, remove the drive belt. • If isolated cam does not rotate, replace drive module. • Connect motor to a 5V power supply (red wire to positive) and verify that drive runs smoothly. • If motor does not operate, it must be replaced. **J. Mechanical interference from pump shaft** • Clean and lubricate if necessary. • Ensure that pump shaft bearings are properly seated. • Install a bearing clip, if missing. • Remove drive module and ensure that pump shaft moves smoothly. **K. Mechanical interference from valve actuators** • Remove drive module. • Verify that valve actuators move smoothly. • Verify that valve actuator springs are seated properly. • Check actuator bearings for smooth operation. • Replace defective components if necessary.

(Table continued next page)

Table 6-12. *Drive System Errors (Cont.)*

Symptom	Possible Cause and Action
7. Event code 282 or 283: Pump motion hindered.	**A. Cassette piston sleeve lifted** • Remove the cassette and reseat the piston sleeve. **B. Mechanical interference from latching mechanism** • Remove the lower housing. • Remove a piston from a cassette. Place cassette piston in pump latch and close the latch. • Verify that pump latch does not bind with the slide link. **C. Drive belt slipping** • Inspect drive belt and pulleys to ensure they are free from lubricant. Replace if contaminated. • With display module attached via the extender cable, operate instrument with a fluid-filled cassette. Apply load by pinching off outlet tubing. Inspect for slippage under this load. If the belt slips, clean cam and replace belt. **D. Defective power supply PCBA** • Test with replacement power supply PCBA. • If problem does not repeat, replace suspect PCBA. **E. Defective drive module or motor** • Remove a piston from a cassette. • Put the piston in the pump latch and close the latch. • Verify that the pump latch does not bind with the slide link. • Rotate affected drive cam manually, being careful not to get grease on the belt. • If cam does not rotate smoothly, remove the drive belt. • If isolated cam does not rotate, replace drive module. • Connect motor to a 5V power supply (red wire to positive) and verify that drive runs smoothly. • If motor does not operate, it must be replaced. **F. Mechanical interference from pump shaft** • Remove drive module and ensure that pump shaft moves smoothly. • Clean and lubricate if necessary. • Install a bearing clip, if missing. • Ensure that pump shaft bearings are properly seated. **G. Mechanical interference from valve actuators** • Remove drive module. • Verify that valve actuators move smoothly. • Verify that valve actuator springs are seated properly. • Check actuator bearings for smooth operation. • Replace defective components if necessary. **H. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

(Table continued next page)

Table 6-12. Drive System Errors (Cont.

Symptom	Possible Cause and Action
8. Event codes 278, 297 & 298: Drive system error.	**A. Defective MEA** • Replace MEA.
9. Pump does not home during power-up and no fault 275.	**A. Dirt in optomodule or slide link sensing area** • Clean optomodule, using procedures described in Chapter 4. **B. Cassette I.D. optics defective, dirty or wet** • Test with replacement cassette. • If problem does not repeat, the cassette optics may have been defective, dirty or wet. • Return defective cassettes to the Technical Service Dept. **C. Optomodule flex dirty** • Remove main housing and expose optomodule flexes. • Clean optomodule flex pads with hard rubber eraser and isopropyl alcohol. **D. Optomodule flex not seated** • Remove main housing and expose the optomodule flex connectors. • Inspect and reseat flex. Ensure that the flexes are centered properly. **E. Defective MEA** • Replace MEA when previous procedures fail to indicate the source of the problem.

Table 6-13. Air-in-Line Sensor Problems

Symptom	Possible Cause and Action
1. False *Check Air Sensor* advisories, cassette in place, or False *Air-in-line* alarms.	**A. Tubing not seated properly or bubbles present** • Refer to Directions For Use for proper priming and installation procedures. **B. Sensor tubing recess dirty** • Clean sensor tubing recess, using procedures described in Chapter 4. **C. Air-in-line sensor connector not seated** • Remove main housing and reseat sensor connectors. **D. Air-in-line sensor defective** • Inspect module for broken glue joints; replace if necessary. • Unplug the suspect sensor module and connect a replacement module. • Place outlet tubing of a primed cassette in the test sensor tubing slot. • Repeat test in which problem occurred. • If problem does not repeat, replace the suspect sensor module. **E. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
2. *Check Air Sensor* advisory without a cassette installed.	**A. Cassette sensor dirty and pump latch closed** • Open latch. • Clean optomodule sensors, using the procedures described in Chapter 4. **B. Cassette sensor dirty and latch sensor defective** • Clean optomodule sensors, using the procedure described in Chapter 4. • Remove slide link, using procedure described in Chapter 7. • Inspect reflector and replace if damaged. **C. Defective Optomodule** • Measure input and output of the optomodule, as described in Figure 6-1 and 6-2. • If input signals are correct but the output signals are incorrect, replace the optomodule.
3. Fails air bubble functional test.	**A. Test not performed properly** • The pump must infuse a volume of air greater than the air detector threshold for an alarm to occur (see Chapter 3). **B. Air-in-line sensor defective** • Inspect module for broken glue joints; replace if necessary. • Unplug the suspect sensor module and connect a replacement module. • Place outlet tubing of a primed cassette in the test sensor tubing slot. • Repeat test in which problem occurred. • If problem does not repeat, replace the suspect sensor module.
4. Event codes 286, 287, 288, 294 & 295: Air sensor error.	**A. Air-in-line sensor connector not seated** • Remove main housing and reseat the connector. **B. Air-in-line sensor defective** • Inspect module for broken glue joints; replace if necessary. • Unplug the suspect sensor module and connect a replacement module. • Place outlet tubing of a primed cassette in the test sensor tubing slot. • Repeat test in which problem occurred. • If problem does not repeat, replace the suspect sensor module. **C. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

Table 6-14. Patient-Side Occlusion Detector Problems

Symptom	Possible Cause and Action
1. False alarms, or alarms when pressure is too low.	**A. Defective cassette** • Inspect the cassette to ensure that the pressure sensing dome is flat and flush with the cassette body. **B. Interference between cassette and pressure transducer** • Inspect the pressure transducer area in the chassis to ensure that it is free of foreign debris. Clean with mild detergent solution if needed. **C. Improper calibration** • Recalibrate, ensuring correct pressures are applied (see Chapter 5). **D. Pressure transducer connector loose or defective** • Remove main housing and display module. • Reseat pressure transducer connector. **E. Defective pressure transducer** • Inspect for broken wires. Replace transducer if any wires are broken. • Using the pressure transducer jumper cable, connect the suspect transducer to a channel that operates properly. • Recalibrate the replacement channel; but, apply pressure to the suspect transducer. • If the problem recurs, replace the suspect transducer. **F. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
2. Patient-side occlusion alarm does not occur at specified pressure.	**A. Improper calibration** • Recalibrate, ensuring the correct pressures are applied (see Chapter 5). **B. Pressure transducer connector loose or defective** • Remove main housing and display module. • Reseat pressure transducer connector. **C. Defective pressure transducer** • Inspect for broken wires. Replace transducer if any wires are broken. • Using the pressure transducer jumper cable, connect the suspect transducer to a channel that operates properly. • Recalibrate the replacement channel; but, apply pressure to the suspect transducer. • If the problem recurs, replace the suspect transducer. **D. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
3. Event code 270 or 280: Pressure sensor error.	**A. Pressure transducer connector loose or defective** • Remove main housing and display module. • Reseat pressure transducer cable. **B. Defective pressure transducer** • Inspect for broken wires. Replace transducer if any wires are broken. • Using pressure transducer jumper cable, connect the suspect transducer to a channel that operates properly. • Recalibrate the replacement channel; but, apply pressure to suspect transducer. • If problem recurs, replace the suspect transducer. **C. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

Table 6-15. Fluid-Side Occlusion Detector Problems

Symptom	Possible Cause and Action
1. False alarms.	**A. Cassette lubrication inadequate** • Exceeding cassette-use specification can result in loss of lubrication. If cassette is new and defective, please contact the Customer Service Department. **B. Improper calibration** • Recalibrate, ensuring correct procedures (see Chapter 5). **C. Mechanical interference from latching mechanism** • Remove the lower housing. • Remove a piston from a cassette. Place cassette piston in pump latch and close the latch. • Verify that the pump latch does not bind with the slide link. **D. Defective drive module or motor** • Remove a piston from a cassette. • Put the piston in the pump latch and close the latch. • Verify that the pump latch does not bind with the slide link. • Rotate affected drive cam manually, being careful not to get grease on the belt. • If cam does not rotate smoothly, remove the drive belt. • If isolated cam does not rotate, replace drive module. • Connect motor to a 5V power supply (red wire to positive) and verify that drive runs smoothly. • If motor does not operate, then replace. **E. Mechanical interference from pump shaft** • Ensure that pump shaft bearings are properly seated. • Install a bearing clip, if missing. • Remove drive module and ensure that pump shaft moves smoothly. Clean and lubricate if necessary. **F. Mechanical interference from valve actuators** • Remove drive module. • Verify that valve actuators move smoothly. • Verify that valve actuator springs are seated properly. • Check actuator bearings for smooth operation. • Replace defective components if necessary. **G. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.
2. Does not pass functional test.	**A. Defective cassette** • Exceeding cassette-use specification can result in loss of lubrication. If cassette is new and defective, please contact the Customer Service Department.

(Table continued next page)

Table 6-15. *Fluid-Side Occlusion Detector Problems (Cont.)*

2. Does not pass functional test (continued).	**B. Defective cassettes during calibration** • Check for smooth operation of the piston. • Note that a piston sleeve must not be used with this cassette. • Last elastomeric valve area in the cassette must be removed. • Replace cassette if defective. **C. Mechanical interference from latching mechanism** • Remove lower housing. • Remove a piston from a cassette. Place cassette piston in pump latch and close the latch. • Verify that pump latch does not bind with the slide link. **D. Defective drive module or motor** • Remove a piston from a cassette. • Put the piston in the pump latch and close. • Verify that the pump latch does not bind with the slide link. • Rotate affected drive cam manually, being careful not to get grease on the belt. • If isolated cam does not rotate, replace drive module. • Connect motor to a 5V power supply (red wire to positive) and verify that drive runs smoothly. • If motor does not operate, then replace. **E. Mechanical interference from pump shaft** • Ensure that pump shaft bearings are properly seated. • Install a bearing clip, if necessary. • Remove drive module and ensure that pump shaft moves smoothly. Clean and lubricate if necessary. **F. Mechanical interference from valve actuators** • Remove drive module. • Verify that valve actuators move smoothly. • Verify that valve actuator springs are seated properly. • Check actuator bearings for smooth operation. • Replace defective components if necessary. **G. Defective MEA** • Replace MEA when the above procedures fail to indicate the source of the problem.

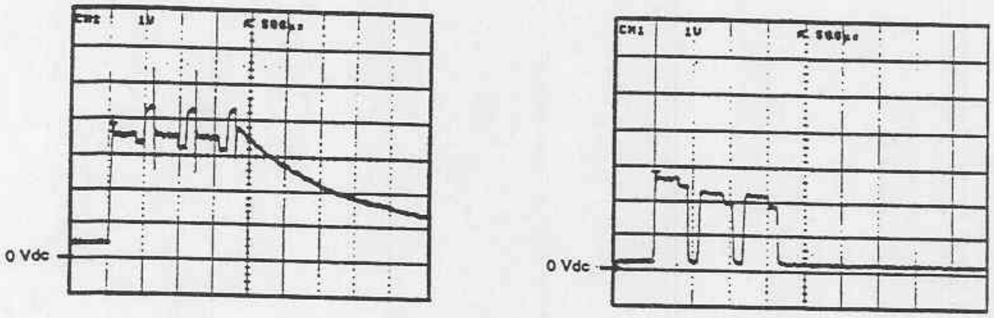
Table 6-16. Instrument Won't Shut Off

- Disconnect the NiCd battery pack to shut the instrument off.
- Plug in a NiCd battery pack that has been charged for at least 1 hour.
- Turn on the instrument by pressing the ON/OFF key and troubleshoot using the observed response.

NOTE: The instrument may have turned on when the battery pack is first connected. This is a normal occurrence, depending on how the circuitry is initialized when battery power is first applied.

Symptom	Possible Cause and Action
1. Turns on, but will not turn off.	**A. Defective keypad** • If there are no beeps or other instrument responses when the ON/OFF key is pressed, then replace the keypad. **B. Defective power supply PCBA** • If there are three beeps when the ON/OFF key is pressed to turn off the instrument, replace the power supply PCBA. **C. Defective MEA** • Replace MEA when the above procedures fail to eliminate the problem.
2. Instrument watchdogs and can't be turned off.	**A. Defective keypad** • If there are no beeps or other instrument responses when the ON/OFF key is pressed, replace the keypad. **B. Defective power supply PCBA** • If there are three beeps when the ON/OFF key is pressed to turn off the instrument, replace the power supply PCBA. **C. Defective watchdog circuit on the MEA** • Replace the MEA when the above procedures fail to eliminate the problem.
3. Instrument watchdogs, but can be turned off.	**Refer to Table 6-3.**
4. Instrument will not turn on at all.	**Refer to Table 6-2.**

Figure 6-1. Cassette I.D. Signals at Optomodule Connector (S5, S6, S7) Located on MEA Mother Board

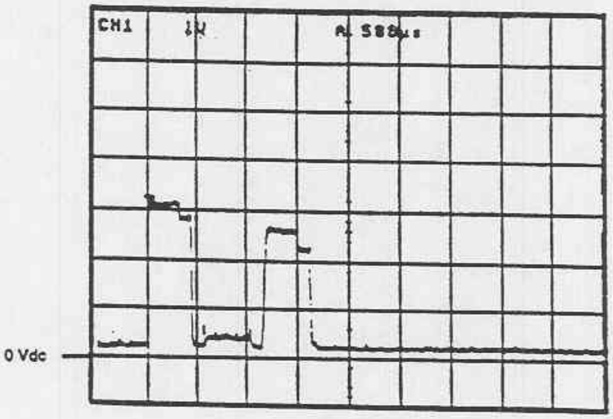


NOTE: High levels should be between 3.0V to 4.5V. Disregard high-frequency spikes.

A. NORMAL INPUT SIGNAL AT PIN 1.

NOTE: There should be three high-level pulses within the range of 0.8V to 4.2V.

B. NORMAL OUTPUT SIGNAL AT PIN 8 WITHOUT A CASSETTE INSTALLED.

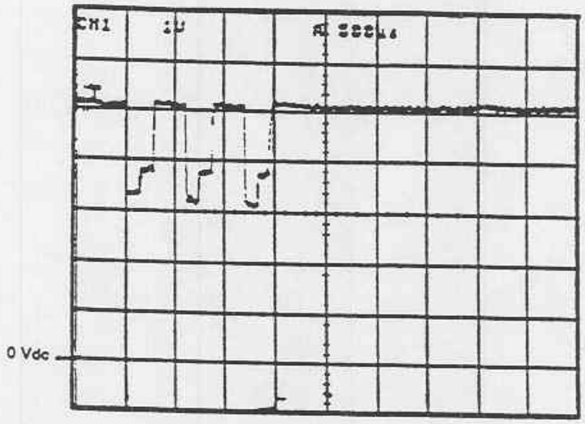


NOTE: There should be two high-level pulses within the range of 0.8V to 4.2V.

C. NORMAL OUTPUT SIGNAL AT PIN 8 WITH A CASSETTE INSTALLED.

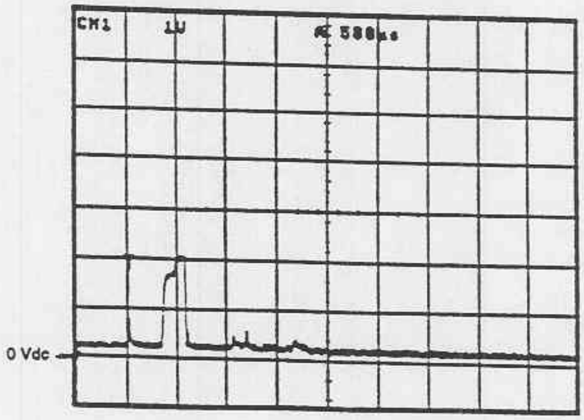
NOTE: Pin 1 is indicated by the square solder tab. Set oscilloscope for a sweep speed of 500 microseconds per division, vertical sensitivity at 1V per division, and DC coupling.

Figure 6-2. Latch Sensor Signals at Optomodule Connector (S5, S6, S7) Located on MEA Mother Board



NOTE: There should be three pulses with the amplitudes dropping from 5.0V to a range between 3.0V and 4.0V.

A. NORMAL INPUT SIGNAL AT PIN 9.



NOTE: There should be one pulse with an amplitude range between 0.8V and 4.2V.

B. NORMAL OUTPUT SIGNAL AT PIN 11 WITH A CASSETTE INSTALLED.

NOTE: Pin 1 is indicated by the square solder tab. Set oscilloscope for a sweep speed of per 500 microseconds per division, vertical sensitivity at 1V per division, and DC coupling.

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Chapter 7
Repair

WARNING

It is recommended that only qualified personnel who have received the necessary factory authorized training perform repairs on the MedSystem III instrument.

CAUTION

All repairs should be documented in accordance with your institutional policies. Refer to the Joint Commission on Accreditation of Hospitals Organization (JCAHO) guidelines if there are no pre-existing policies at your institution.

7.0 Introduction

This chapter provides detailed procedures for disassembling, replacing parts, and reassembling the MedSystem III. Following are the five main sections of this chapter.

1. Main Housing Assemblies
2. Universal Pole Clamp
3. Mechanical Subsystems
4. Sensors
5. Electronics

Each section lists the major parts and modules in a sequential order for proper disassembly. Before attempting any repairs, it is necessary that you have a good understanding of the principles of operation (Chapter 2), the functional check procedures (Chapter 3), and the calibration procedures (Chapter 5).

For ease in handling during repair, the instrument may be clamped to a table edge with the universal pole clamp. It can then be rotated and tilted in any orientation for easy access to most parts.

In reference to orientation (up, down, top, bottom, right, left), the user should have the instrument in an upright position and should be facing the front panel (Figure 7-1).

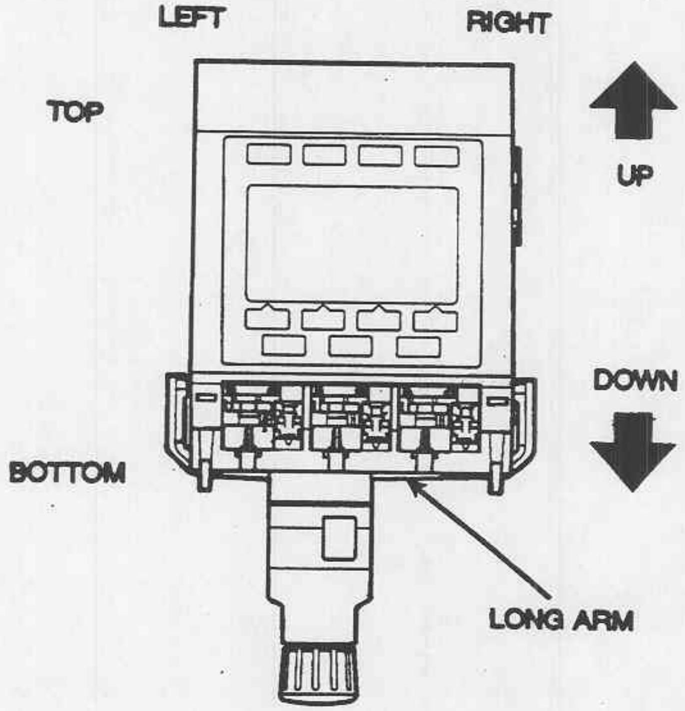
a. Handling Procedures

   Always use the following procedures when handling electronic assemblies or removing the battery pack.

CAUTION

The electronic components used in the MedSystem III instrument can be damaged by electrostatic discharges (ESD).

Figure 7-1. Instrument Orientation during Repair



1. Store PCBAs and transducers in their conductive packaging until ready for use.
2. Wear a 0.5 to 1.5 megohm wrist strap for grounding.
3. Ensure that the workstations have grounded conductive mats or surfaces.
4. All conductive surfaces and equipment must be connected to earth ground.
5. When handling electronic or sensor assemblies, wear clothes that do not generate static.
6. All PCBAs must be handled by the edges.
7. Ideally, room humidity should be kept between 45% and 60%, because static electricity increases exponentially as humidity decreases.
8. For further details, refer to DoD Handbook 263 and DoD Standard 1686.

b. Procedures Following Repair

> **WARNING**
>
> *If indicated, the following procedures must be performed to ensure instrument operates properly before it is used on a patient.*

1. Calibration
   Calibration of sensor systems is required if memory contents are corrupted during repair, or if specific components are replaced. Corruption of memory content is detected by the software during operation (refer to Troubleshooting, Chapter 6, for event codes). Always recalibrate if indicated. Refer to Chapter 5 for calibration instructions.

2. Run-in
   Whenever a repair procedure necessitates removing the main housing, the instrument should be operated in the general purpose mode for a period of time before returning to clinical service.

   Fluid-filled cassettes must be installed during the run-in period. Set up a recirculating system, using a bag of saline.

   If the battery functional tests are not needed, then use the following procedures to run-in the instrument.

   (a) Operate the instrument for 4 hours, using a rate of 275 ml/h on all three channels.

   (b) Operate the instrument for a minimum of 8 hours (i.e., overnight) with all three channels operating at 999 ml/h. This stresses the power supply and pumping mechanisms, and produces a large number of revolutions for self-testing the encoders and air-in-line sensors.

   NOTE: *The order is not important (i.e., 275 ml/h does not need to be first).*

   If the battery functional tests are required, use the following procedures.

   (a) Completely discharge the battery while operating the instrument without the adapter plugged in and with all three channels set at 275 ml/h to test the 5V circuitry. Continue operating past the *Battery Depleted* alarm until the instrument shuts off.

   (b) Charge the instrument for 14 hours while running all three channels at 999 ml/h to test the 13V circuitry.

   (c) Perform the battery operating time functional tests while operating all three channels of the instrument at 125 ml/h (Chapter 3, Section 3.8).

   (d) Recharge the instrument for 14 hours. Make sure that the instrument is turned off.

3. Functional checks
   Checking instrument performance is necessary after repair. Whenever the main housing is removed, perform a complete functional check with the exception of the battery operating time (Chapter 3). It is recommended that, as a minimum, these checks be performed after the run-in. An optional check of function before run-in is desirable (but not necessary) to quickly find any

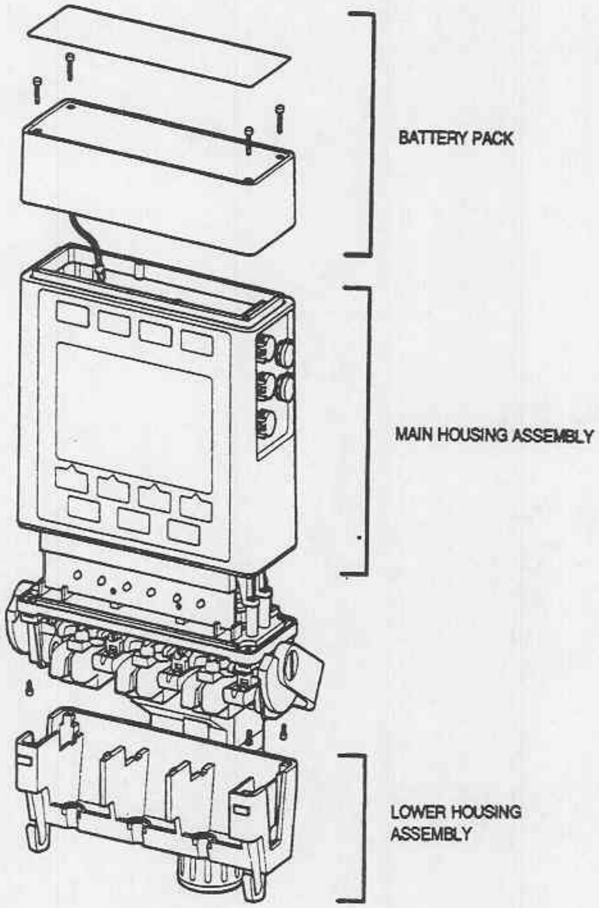
problems. Battery operating time must be checked if the battery, the power supply PCBA, or the MEA are replaced. This operating time can be combined with the run-in procedure (refer to paragraph 2 above).

4. Restoration of Configured Parameters and the Battery History Log
   Memory contents can be corrupted during repair. Instrument settings, such as air-in-line alarm thresholds, may have been customized using Field Maintenance Software (FMS). Settings should always be verified for correctness after repair. The serial number and special message may also need reprogramming. For reprogramming instructions refer to the FMS DFU. The Battery History Log data may have been corrupted also, which necessitates clearing and resetting installation dates.

7.1 Housing Assemblies

An exploded view of the housing assemblies is shown in Figure 7-2.

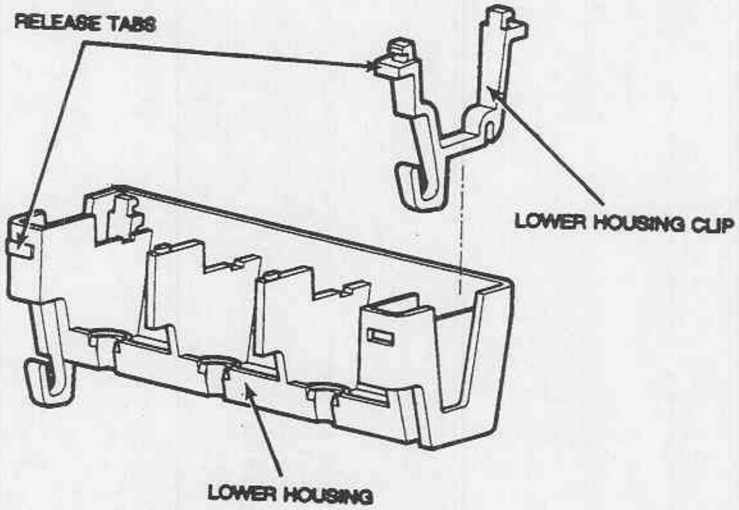
Figure 7-2. ***Exploded View of Housing Assemblies***



7.1.1 Lower Housing Assembly

Figure 7-3 depicts an exploded view of the lower housing and lower housing clips. Use the following procedures when repairing the lower housing.

Figure 7-3. Exploded View of Lower Housing Assembly


RELEASE TABS
LOWER HOUSING CLIP
LOWER HOUSING

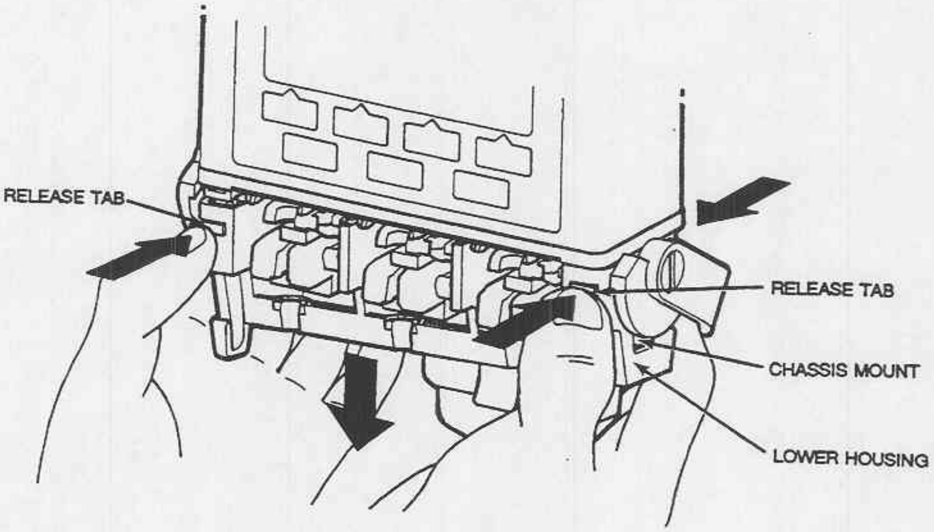
Disassembly

Tool required: Small flat blade screwdriver

a. Remove lower housing assembly.

  1. Locate the four black release tabs (Figure 7-4) in the upper corner of the lower housing.

Figure 7-4. Lower Housing Release Tabs


RELEASE TAB
RELEASE TAB
CHASSIS MOUNT
LOWER HOUSING

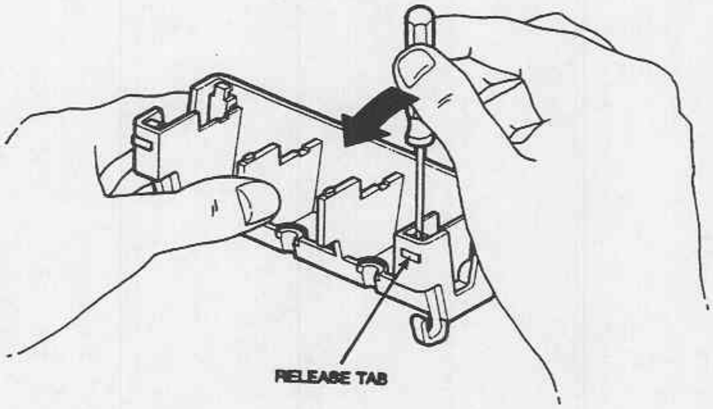
  2. With the instrument upright and firmly mounted using the pole clamp, simultaneously press the front and back tabs on each side with your thumb and fingertips.
  3. While the tabs are depressed, pull the lower housing straight down and away from the instrument.

b. Inspect for the following.
   1. Cracked or chipped housing.
   2. Broken or bent lower housing clips.
   3. Broken chassis mounts.
   4. Cleanliness. If necessary, clean using a mild detergent or disinfectant (Chapter 4, Section 4.1).

Reassembly

a. Replace the lower housing clips.
   1. Locate the two clips on the front of the lower housing toward the sides.
   2. Using a small flat blade screwdriver, pry the black release tabs until they clear the housing slot (Figure 7-5).
   3. Push up on the hook to bring the tab above the slot.
   4. Repeat the procedure for the back of the lower housing clips.
   5. Pull the housing clips from the housing.
   6. Install the lower housing by snapping the clips back into position.

Figure 7-5. Lower Housing Clip Replacement



b. Reattach the lower housing assembly to the chassis.
   1. Arrange the lower housing on the bottom of the case such that the three cutouts are facing forward.
   2. Gently snap the housing up and into place. It is not necessary to press the black buttons to install the lower housing.
   3. Pull down slightly to ensure that all four corners are locked in place. If a corner will not lock, remove the lower housing and inspect the lower housing clips and the chassis mounts. If necessary, replace either the clips or the mounts, or both.

7.1.2 Battery Pack

The battery pack is shown in the exploded assembly diagram (Figure 7-6). Use the following procedures to replace the battery pack.

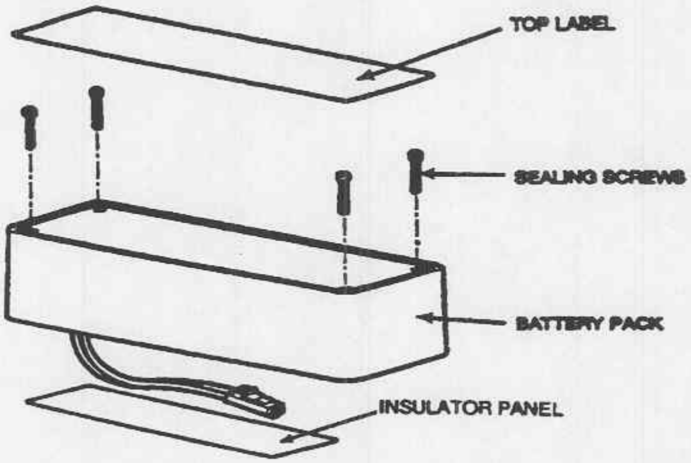
Disassembly

Tool required: #1 Phillips screwdriver

a. Remove the top label (Figure 7-6).

NOTE: *Warming the top label with a heat gun or hair dryer facilitates label removal and minimizes residual adhesive.*

Figure 7-6. Exploded View of Battery Pack



1. Peel up one corner of the label. If a metal tool is used to lift a corner, use care to prevent scratches on the main housing.
2. Pull the label from the surface.
3. Remove residual label adhesive from the top of the battery pack case, using a gentle rubbing motion or oil-free label adhesive remover.
4. Make sure that the surface is clean and free of any contamination.

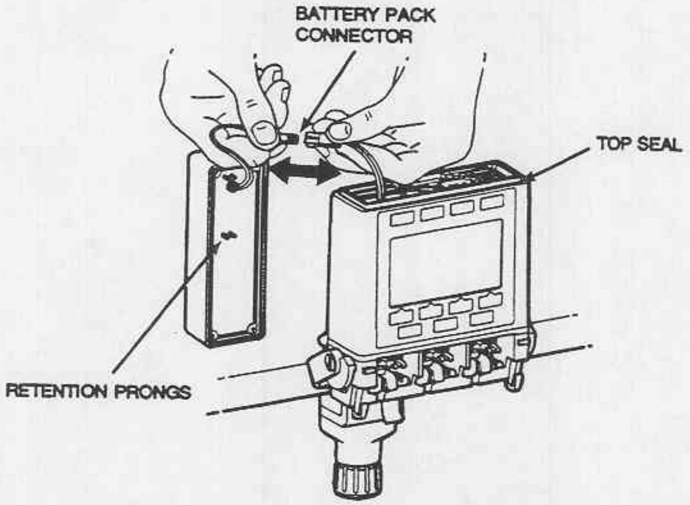
b. Remove the battery pack.

1. Using a #1 Phillips screwdriver, remove the four sealing screws which secure the battery pack (Figure 7-6).
2. Lift the battery pack slowly from the main housing assembly and set it aside. Be careful not to stress the cable.
3. Unplug the battery pack connector (Figure 7-7).

c. Inspect for the following.

1. Cracks and chips.
2. Broken wire or connector.
3. Damage to the top seal in main housing assembly.
4. Broken EPROM retention prongs.

Figure 7-7. *Battery Pack Removal*

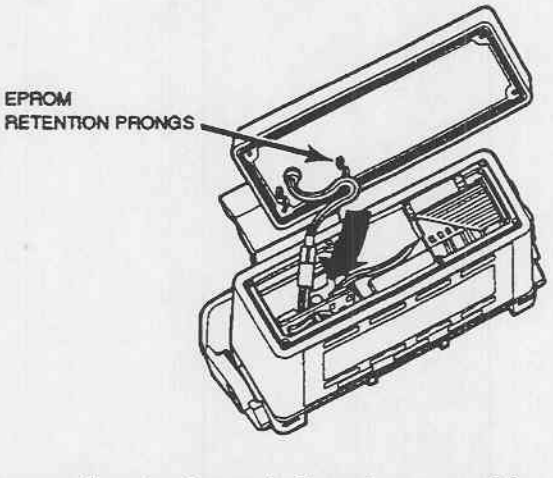


Reassembly

a. Reassemble and reinstall the battery pack. NOTE: If battery was replaced, install insulator panel in center of bottom of battery pack assembly.

1. Ensure that the top seal is properly seated in the groove of the main housing.
2. Reattach the battery connector.
3. Gently place the wires and connector into the space in front of the EPROM PCBA (Figure 7-8).

Figure 7-8. *Battery Pack Reassembly and Reinstallation*



4. Fit the battery pack onto the main housing assembly with the printing on the top readable from the front.
5. Capture the EPROM PCBA with the two retention prongs located on the bottom of the battery pack.
6. Using the #1 Phillips screwdriver, install four **new** sealing screws and tighten until snug. DO NOT OVERTIGHTEN. The screws should not be reused because they contain a seal that can flatten and, hence, may not seal properly.

b. Affix a new top label.

c. Cycle the batteries.
The battery alarms may not be accurate the first time that the NiCad cells are used. Before performing a functional test of battery operating time, completely discharge the batteries by running the instrument at 999 ml/h (all three channels) until shutoff occurs after the *Battery Depleted* alarm. Then charge the batteries for at least 14 hours.

d. Clear the Battery History Log (refer to the FMS DFU).

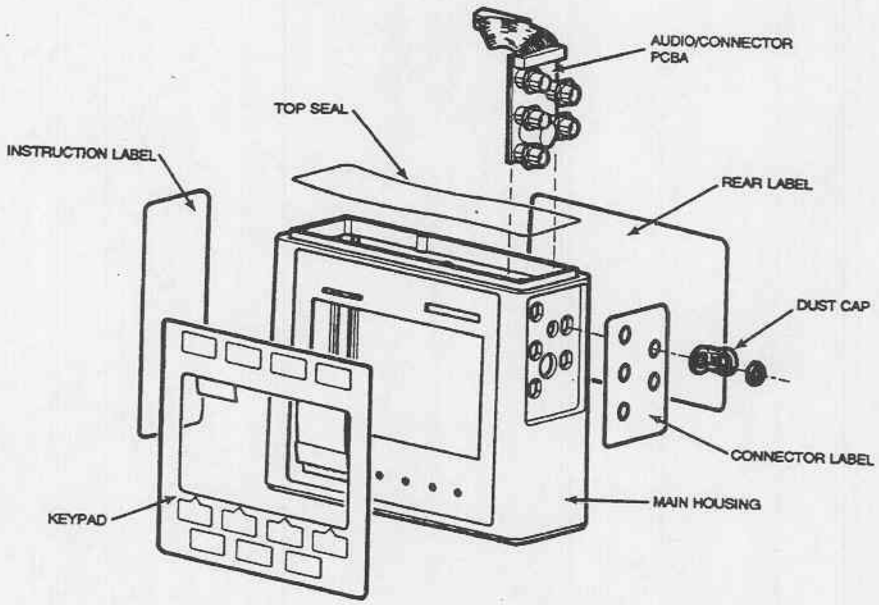
1. Verify that the instrument powers up properly (Chapter 3, Section 3.2).
2. If the battery was replaced, use FMS to clear the Battery History Log. Enter the installation date.
3. For a new battery, verify the proper charging, operating time, and alarms (Chapter 3, Section 3.8).

e. Perform the functional checks (Chapter 3).

7.1.3 Main Housing Assembly

Figure 7-9 is an exploded view of the main housing assembly and related parts. To replace the main housing assembly, use the following steps.

Figure 7-9. Exploded View of Main Housing Assembly



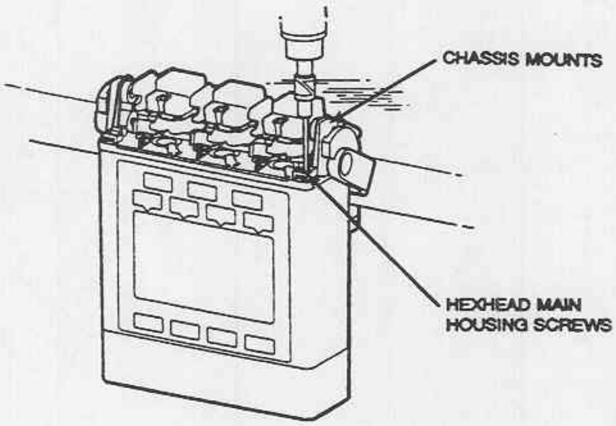
Disassembly

Tools required:
- #1 Phillips screwdriver
- 3/32-inch hex driver
- 5-in. lbf torque driver
- A nonconductive tool

a. First, remove the following.
   1. Battery pack (Section 7.1.2).
   2. Lower housing assembly (Section 7.1.1).

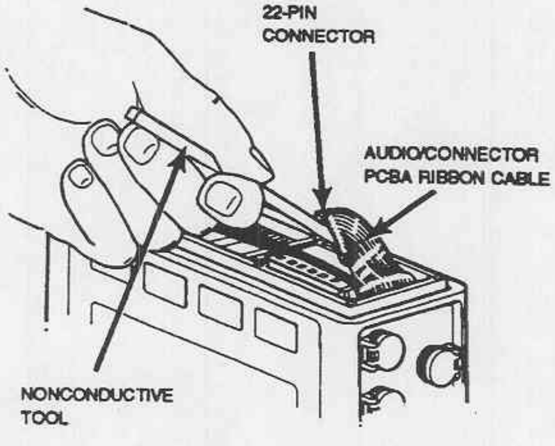
b. Remove the main housing assembly from chassis.
   1. Attach the pole clamp firmly to a table.
   2. Invert the instrument.
   3. Locate the four hex-head main housing screws located in each corner of the chassis (Figure 7-10).

Figure 7-10. Hex-head Screws of Main Housing Assembly Removal


CHASSIS MOUNTS
HEXHEAD MAIN HOUSING SCREWS

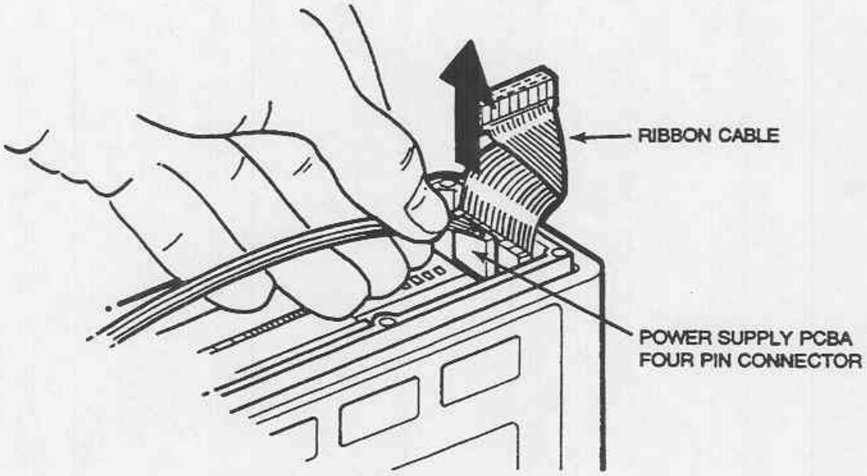
   4. Remove the screws through the square holes in the chassis mounts, using the 3/32-inch hex driver.
   5. Return the instrument to an upright position. On the right side of the instrument is the ribbon cable (Figure 7-11) from the audio/connector PCBA. Using a nonconductive tool, gently pry up the 22-pin connector on the ribbon cable.

Figure 7-11. Audio/Connector PCBA Ribbon Cable


22-PIN CONNECTOR
AUDIO/CONNECTOR PCBA RIBBON CABLE
NONCONDUCTIVE TOOL

6. A four-pin connector from the power supply PCBA is located under the ribbon cable (Figure 7-12). Unplug this connector.

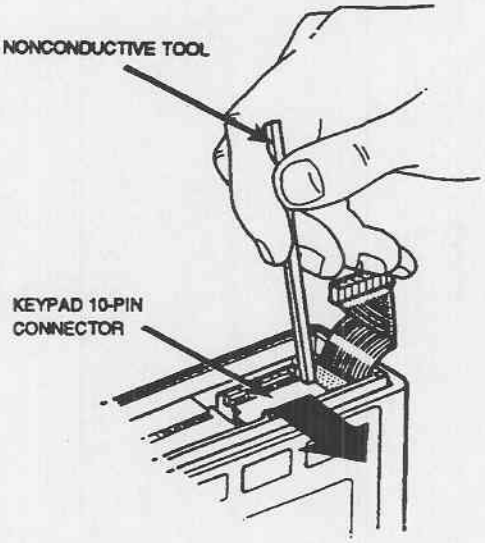
Figure 7-12. Power Supply PCBA Four-Pin Connector


RIBBON CABLE
POWER SUPPLY PCBA
FOUR PIN CONNECTOR

7. To the left of the power supply PCBA connector (under the ribbon cable) is a 10-pin connector from the keypad. Remove this 10-pin connector by pressing forward alternately on one side and then the other, using a nonconductive tool (Figure 7-13).

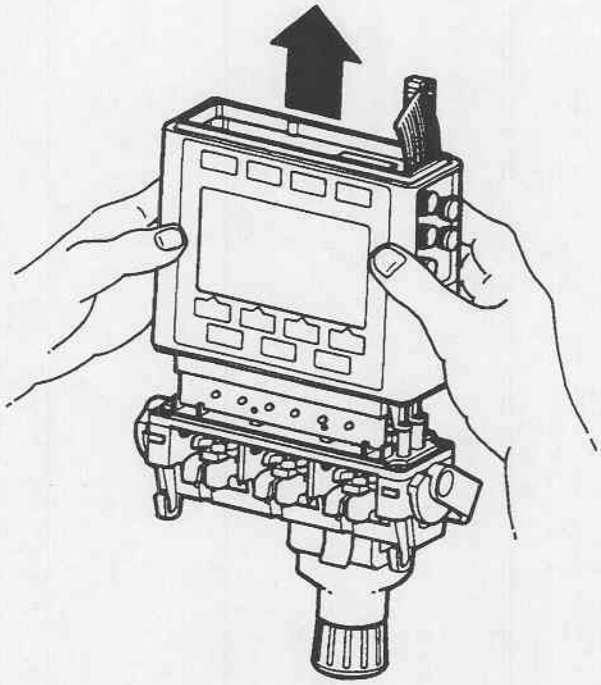
> **CAUTION**
>
> *Be careful not to bend the connector cable excessively while removing the case from the instrument.*

Figure 7-13. Keypad Ten-Pin Connector


NONCONDUCTIVE TOOL
KEYPAD 10-PIN
CONNECTOR

8. Carefully slide the main housing assembly straight up and off the instrument (Figure 7-14).

Figure 7-14. ***Main Housing Assembly***

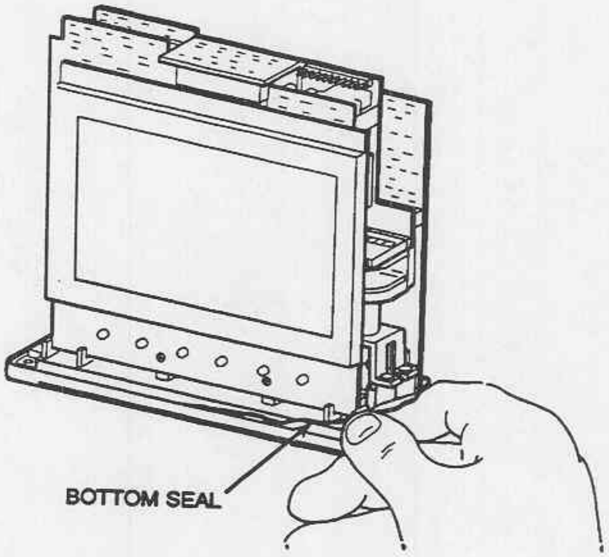


c. Inspect for the following.
   1. The serial number on the underside of the chassis is consistent with the serial number on the rear label.
   2. Cracked or chipped housing.
   3. Broken or loose screw inserts.
   4. Delaminated keypad.
   5. Cracked or damaged keys.
   6. Damaged bottom seal.
   7. Loose connectors.
   8. Broken wires.
   9. Broken or missing dust caps.
   10. Missing or defaced labels.

Reassembly

a. Reassemble the main housing assembly to the chassis.
   1. Ensure that the bottom seal is properly seated on the chassis (Figure 7-15).
   2. Carefully slide the main housing assembly over the internal components until it is seated against the chassis.

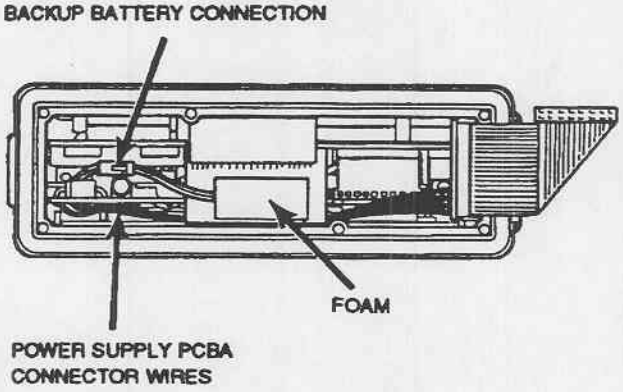
Figure 7-15. ***Bottom Seal Replacement***


BOTTOM SEAL

3. Attach the connectors in the following order: (1) keypad [10-pin], (2) power supply PCBA [4-pin], (3) audio/connector PCBA [22-pin], and (4) battery pack. Place the wires for the power supply PCBA connector as shown in Figure 7-16.

> **CAUTION**
>
> *Be careful not to bend the connector cable excessively while attaching the case to the instrument.*

Figure 7-16. ***Power Supply PCBA Connector Wire Replacement***


BACKUP BATTERY CONNECTION
FOAM
POWER SUPPLY PCBA
CONNECTOR WIRES

4. Depress the ON key and verify that the instrument powers up.
5. Rotate the instrument to orient the bottom of the chassis in an up position.
6. Replace the main housing screws, tightening to a torque of 5 in. lbf.
7. Reassemble the battery to the main housing.

b. Verify the memory contents and restore if necessary.
   1. Turn on the instrument. If calibration parameters have been corrupted, self-tests will produce a fault alarm. If this happens, recalibrate using the procedures referenced in Chapter 5.
   2. Verify that the customized settings are correct (refer to FMS).
   3. Verify that the Battery History Log information has not been corrupted. If corrupted, use FMS and enter the information again.

c. Test
   1. Perform run-in (Section 7.1) and all the functional checks (Chapter 3) except battery operating time.

7.1.4 Dust Cap Replacement

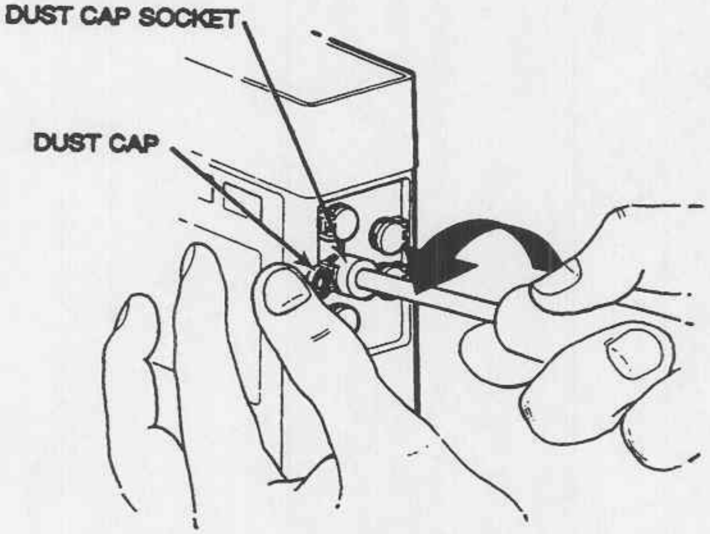
Tool required: Dust cap socket

Disassembly

a. Remove dust caps.
   1. Lift the dust cap (Figure 7-17). Using the dust cap socket, remove the retaining nut by turning counterclockwise.

b. Remove the dust cap, noting its orientation.

Figure 7-17. Dust Cap Removal



Reassembly

a. Replace the following.
   1. Using the retaining nut, secure the dust cap in the proper orientation.
   2. Use care to prevent cross-threading or overtightening of the nut. Very little force is required to hold the cap in place and prevent it from spinning.

b. Perform the following functional tests (Chapter 3).

   1. Electrical safety.
   2. Power-up and AC indication.
   3. Communications.

7.1.5 Rear Label and Instruction Label Removal and Replacement

NOTE: *Some instruments have rear labels with the UL approval symbol on the label. Others have the UL symbol affixed on the bottom of the chassis.*

a. Remove the rear label.

   NOTE: *Warming the rear label with a heat gun or hair dryer facilitates label removal and minimizes residual adhesive.*

   1. Peel up one corner of the label. If a metal tool is used to lift a corner, use care to prevent scratching the main housing.
   2. Pull the label from the surface.
   3. Remove any residual label adhesive from the main housing by using a gentle rubbing motion or label adhesive remover.
   4. Make sure that the surface is clean and free of any contamination.

Reassembly

a. Replace the rear label.

   1. Attach the rear label to the main housing.

b. Replace the instruction label.

   1. If the instruction label needs to be replaced, attach the new label in the same location as the old one.

7.1.6 Audio/Connector PCBA and Label Replacement

Tools required:

- #1 Phillips screwdriver
- 3/32-inch hex driver
- Dust cap socket
- Silicone sealant (Dow Corning 739 or equivalent)

Disassembly

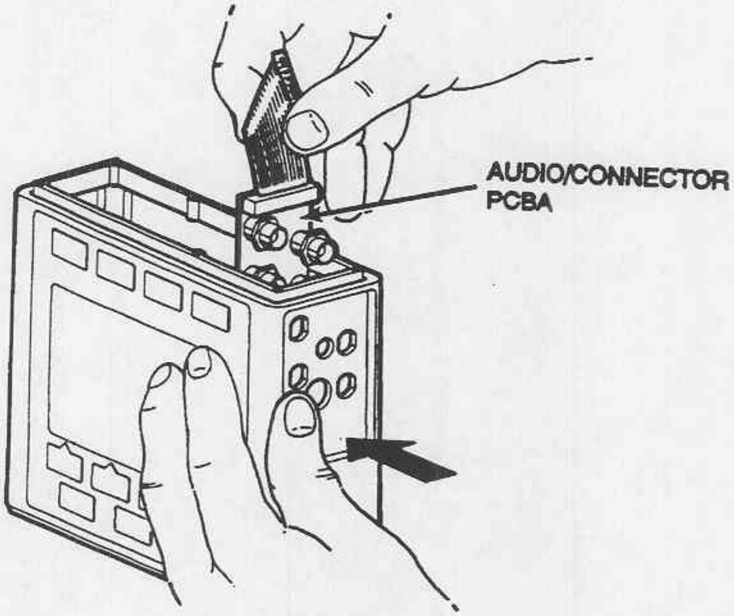
a. First, remove the following.

   1. Lower housing assembly (Section 7.1.1).
   2. Battery pack (Section 7.1.2).
   3. Main housing assembly (Section 7.1.3).
   4. Dust caps (Section 7.1.4).

b. Remove the PCBA.

   1. Gently press the connectors through the holes in the main housing.
   2. Remove the PCBA (Figure 7-18).

Figure 7-18. Audio/Connector PCBA Removal

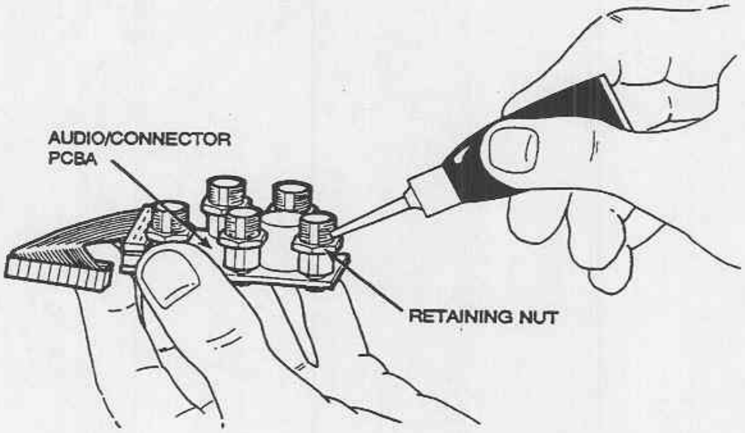


Reassembly

NOTE: *The INSIDE retaining nuts on each connector are set at the factory to a precise position for proper dust cap operation. DO NOT change the position of these nuts.*

1. Remove and clean any old sealant from the connectors.
2. Seal the gap between the housing and the connectors (Figure 7-19) by applying a small amount of silicone sealant around each connector before the audio/connector PCBA is installed. Do not overapply sealant.
3. Replace the audio/connector PCBA. Secure with retaining nuts and dust caps, as described in Section 7.1.4.

Figure 7-19. Sealant Application



4. Replace the EXTERNAL POWER/COMM label if necessary.

a. Reassemble the instrument in the following order.
   1. Main housing assembly (Section 7.1.3).
   2. Battery pack (Section 7.1.2).
   3. Lower housing assembly (Section 7.1.1).

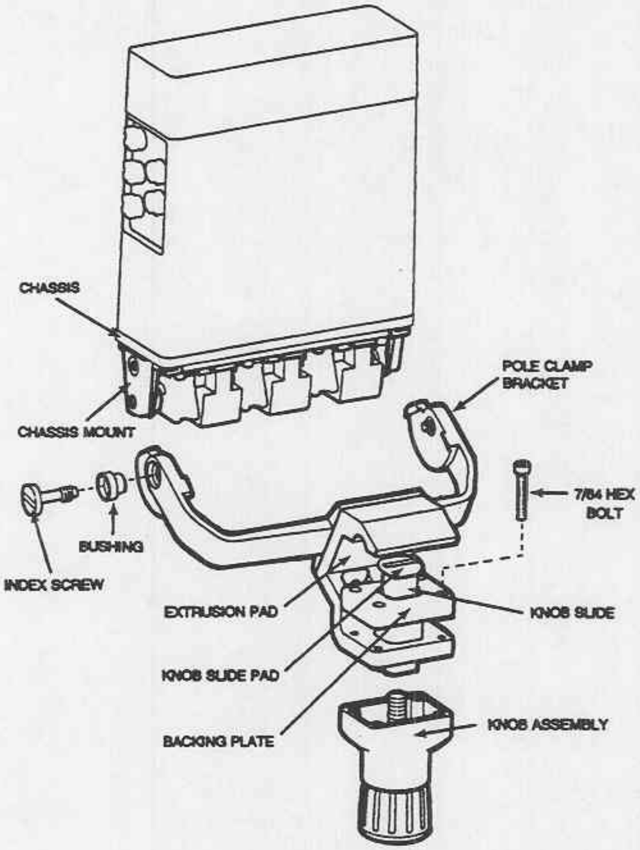
b. Verify the memory contents and restore if needed.
   1. Turn on the instrument. If calibration parameters have been corrupted, self-tests will produce a fault alarm. If this happens, recalibrate using the procedures referenced in Chapter 5.
   2. Verify that the customized settings are correct (refer to FMS).
   3. Verify that the Battery History Log information has not been corrupted. If corrupted, use FMS and enter the information again.

c. Test.
   1. Perform run-in (Section 7.1) and all the functional tests (Chapter 3) except the battery operating time.

7.2 Universal Pole Clamp

Figure 7-20 shows an exploded view of the universal pole clamp and related parts.

Figure 7-20. Exploded View of Universal Pole Clamp and Related Parts


CHASSIS
CHASSIS MOUNT
POLE CLAMP BRACKET
7/64 HEX BOLT
BUSHING
INDEX SCREW
EXTRUSION PAD
KNOB SLIDE
KNOB SLIDE PAD
KNOB ASSEMBLY
BACKING PLATE

7.2.1 Pole Clamp Assembly Replacement

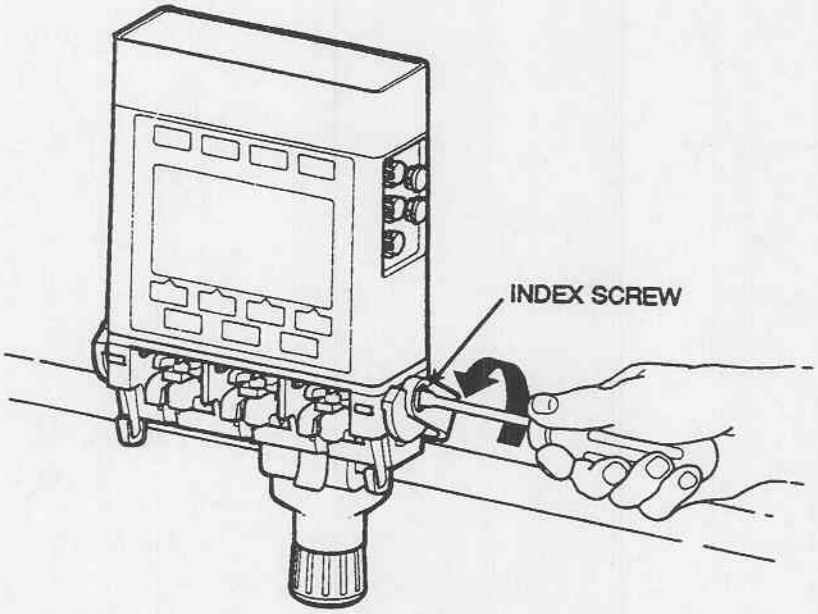
Tool required: 5/16-inch flat blade screwdriver

Disassembly

a. Remove the pole clamp from the instrument.

   1. Loosen the two index screws located on either side of the bracket (Figure 7-21), using a 5/16-inch flat blade screwdriver or a coin. It is not necessary to completely remove the screws to separate the pole clamp from its mounts.

Figure 7-21. Location of Pole Clamp Bracket Index Screws



b. Inspect for the following.

   1. Bent bracket on either side that scrapes the housing.
   2. Broken or loose knob assembly.
   3. Clutch out of adjustment or broken.
   4. Missing or damaged pads.

Reassembly

a. Reattach the pole clamp to the instrument.

   1. Position the bracket so that the two index screws are aligned over the threaded holes in the chassis mount.
   2. Tighten the screws until they are snug (DO NOT overtighten).
   3. Replace the screws if they loosen when the instrument is tilted several times front to back.

b. Check to ensure the following.

   1. The pole clamp pivots properly on the chassis mounts and the knob turns freely.

2. The clutch is properly adjusted. A solid "click" sound should be heard when the knob is tightened completely (refer to Section 7.3.2 if the clutch needs adjustment).

7.2.2 Pole Clamp Bracket, Knob Assembly, or Slide Replacement

Tools required:

- 5/16-inch flat blade screwdriver
- 7/64-inch ball-end hex wrench
- 5/64-inch hex wrench

Disassembly

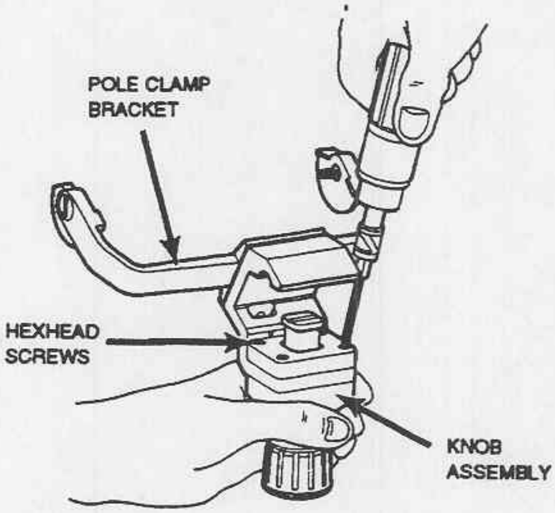
a. First, remove the following.

1. Pole clamp assembly from the instrument (Section 7.3.1).

b. Disassemble the knob assembly.

1. Separate the knob assembly from the pole clamp bracket by removing the four hexhead screws, using a 7/64-inch ball-end hex wrench (Figure 7-22).

Figure 7-22. Knob Assembly



2. After removing the screws, turn the knob clockwise while pulling back on the knob assembly (Figure 7-23).
3. Continue this procedure until the knob assembly slide is completely unscrewed from the threaded shaft.
4. Remove the knob assembly slide by pressing the backing plate out of the square hole in the mount (Figure 7-24).

Reassembly

Reverse the order of disassembly.

When mounting the pole clamp, the long arm of the pole clamp bracket must be to the right, as shown in Figure 7-1.

Figure 7-23. **Knob Assembly Slide**

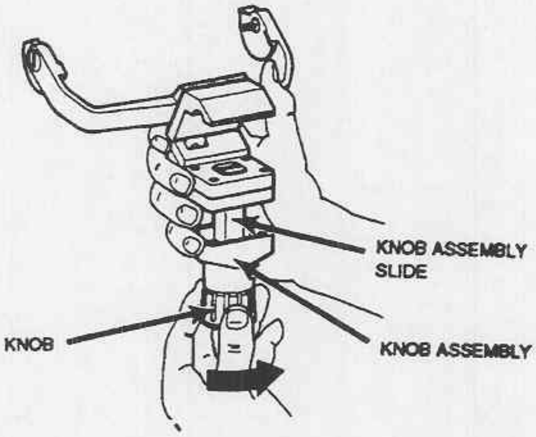
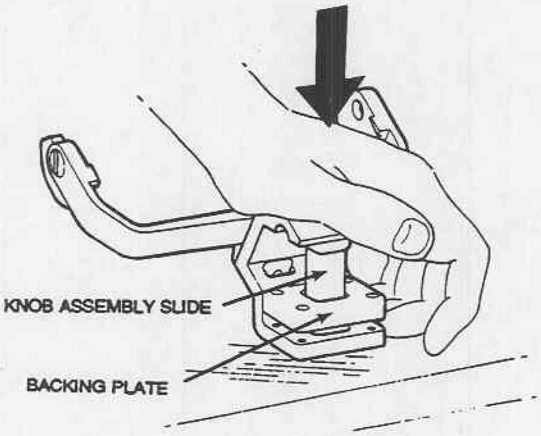


Figure 7-24. **Knob Assembly Clutch Adjustment Screw**



a. Adjust the clutch.

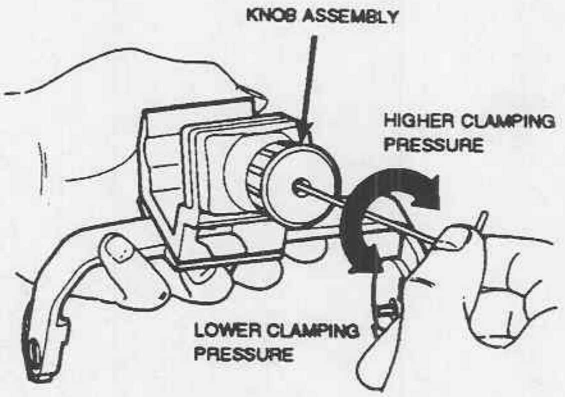
The pole clamp contains a slip clutch that allows consistent tightening to the proper pressure.

1. Using a 5/64-inch hex wrench, turn the clutch adjustment screw in the back of the knob assembly clockwise until it stops (Figure 7-25).
2. Back the screw out counter-clockwise for one-half turn.
3. The clamping pressure may be adjusted tighter by turning the screw clockwise, or looser by turning counterclockwise.

b. Inspect to ensure the following.

1. The pole clamp pivots properly on the mounts, and the knob turns freely.
2. The clutch is adjusted properly. A solid "click" sound is produced when the knob is completely tightened.

Figure 7-25. Knob Assembly Slide Removal



7.2.3 Knob Assembly Slide Cap Replacement

Tools required:

- Isopropyl alcohol
- Lint-free swabs
- Loctite® 401 Superbonder

Disassembly

a. Remove the following.

   1. Damaged slide cap from the knob assembly slide.

b. Clean the following.

   1. Any remaining dried adhesive from the top of the knob assembly slide.
   2. The top of the knob assembly slide, using a clean swab and isopropyl alcohol.

Reassembly

a. Before beginning the reassembly, perform the following steps.

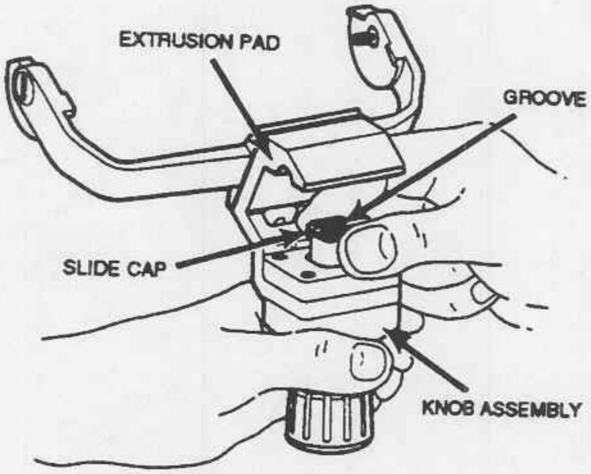
   1. Clean the inside of the slide cap, using a clean swab moistened with isopropyl alcohol.
   2. Apply a drop of Loctite 401 inside each corner.

b. After the above steps have been completed, perform the following.

   1. Install the slide cap on the top of the knob assembly slide, ensuring that the groove in the slide cap is parallel to the groove in the extrusion pad (Figure 7-26).

> **CAUTION**
>
> *Further disassembly of the pole clamp is not recommended. Special equipment is necessary for reassembly beyond this point.*

Figure 7-26. Knob Assembly Slide Cap Replacement



7.2.4 Pole Clamp Bracket Bushing Replacement

Tool required: 5/64-inch flat blade screwdriver

Disassembly

1. First, remove the pole clamp assembly from the instrument (Section 7.2.1).
2. Remove the index screw.
3. Using a blunt instrument, push out the bushing from the inside of the pole clamp bracket (refer to Figure 7-21 for the bushing location).

Reassembly

1. Using a blunt instrument, press in the bushing until it snaps in place.
2. Replace the index screw.
3. Reattach the pole clamp to the instrument (Section 7.2.1).

7.3 Mechanical Subsystems

The mechanical subsystems are depicted in detail in Figure 7-27.

NOTE: *Two different types of chassis were produced. Early versions were machined from aluminum, and the later versions are die cast. The machined aluminum versions are silver colored and can also be identified by the white plastic pump shaft sleeve bearings (Figure 7-28). Die cast chassis use a shorter air-in-line sensor module seal.*

7.3.1 Pump Latch Assembly and Pump Shaft Seal

Tools required:

- #1 Phillips screwdriver
- 3/32-inch hex driver
- 5/16-inch flat blade screwdriver
- Chassis holding stand
- 0.05-inch hex driver

Figure 7-27. **Exploded View of Mechanical Assembly**

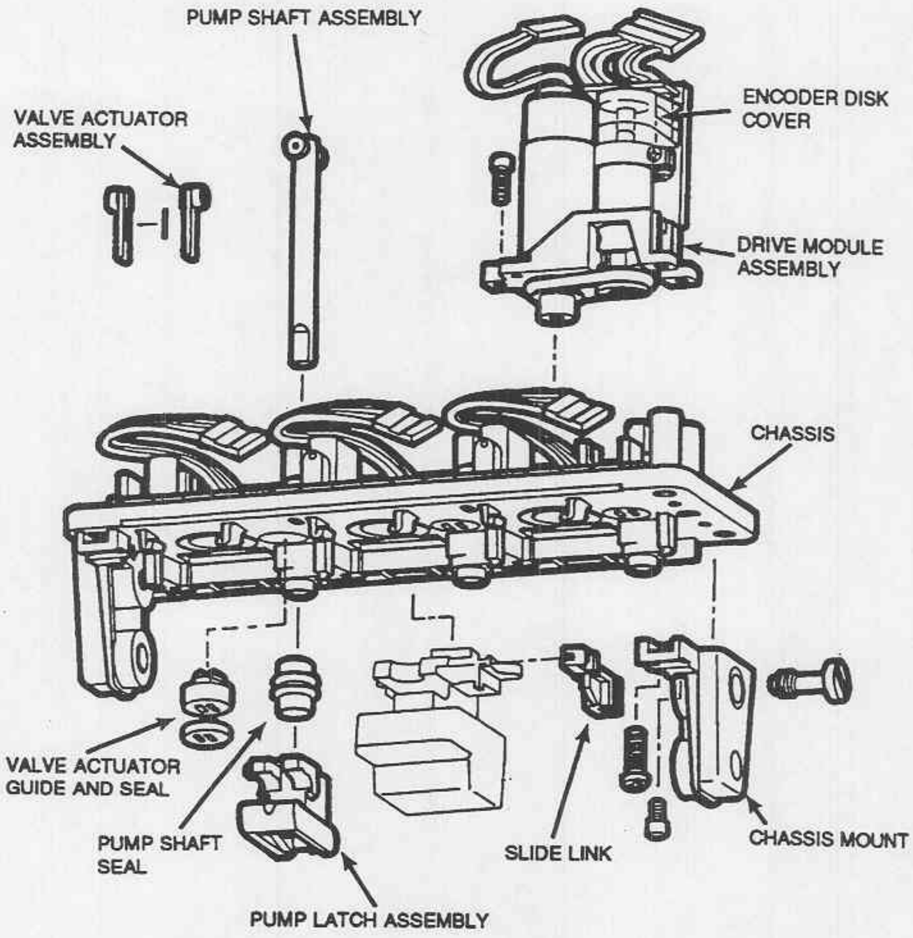
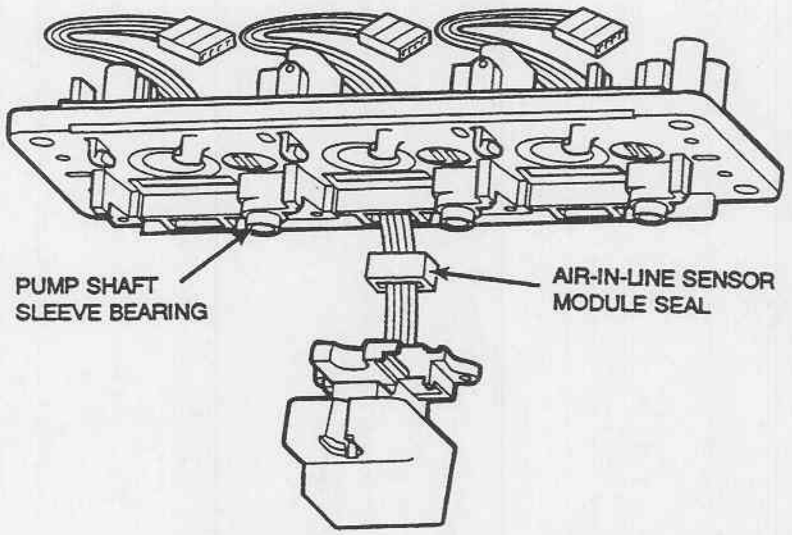

PUMP SHAFT ASSEMBLY
VALVE ACTUATOR ASSEMBLY
ENCODER DISK COVER
DRIVE MODULE ASSEMBLY
CHASSIS
VALVE ACTUATOR GUIDE AND SEAL
PUMP SHAFT SEAL
SLIDE LINK
CHASSIS MOUNT
PUMP LATCH ASSEMBLY

Figure 7-28. **Machined Aluminum Chassis (Model 2860 only)**

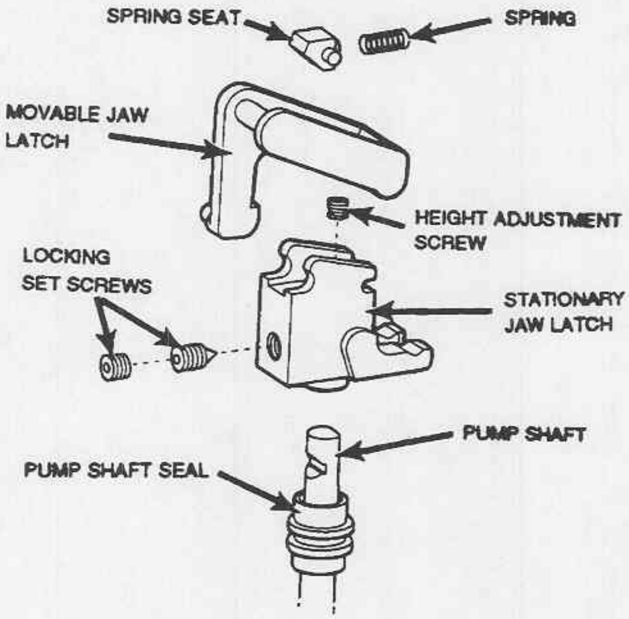

PUMP SHAFT SLEEVE BEARING
AIR-IN-LINE SENSOR MODULE SEAL

Tools required (continued):

- 0.05-inch Allen key
- 5-in. lbf torque driver
- 3-in. lbf torque driver
- 5/64-inch ball-end hex driver or T-6 Torx driver
- Loctite® Assure 425 surface curing threadlocker
- Gauge block kit

NOTE: *It is not necessary to lubricate any moving parts of the pump latch assembly (Figure 7-29).*

Figure 7-29. Exploded View of Pump Latch

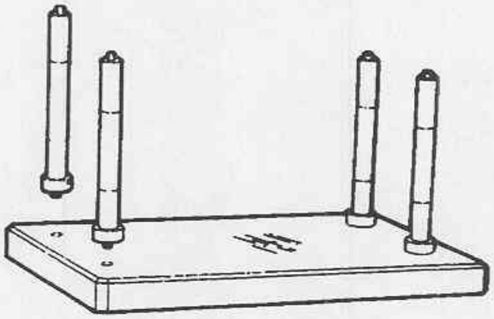

SPRING SEAT
SPRING
MOVABLE JAW LATCH
HEIGHT ADJUSTMENT SCREW
LOCKING SET SCREWS
STATIONARY JAW LATCH
PUMP SHAFT
PUMP SHAFT SEAL

Disassembly

a. First, remove the following.
   1. Lower housing assembly (Section 7.1.1).
   2. Battery pack (Section 7.1.2).
   3. Main housing assembly (Section 7.1.3).
   4. Display module (Section 7.5.2).
   5. Pole clamp assembly (Section 7.2.1).
   6. Ground wire from the chassis (Section 7.5.5).
   7. Backup battery from the locking two-pin connector (Section 7.5.3).
   8. All motor, encoder, and pressure transducer connections from the MEA (Section 7.4.2).

b. Assemble the chassis holding stand.
   1. Screw each of the four chassis-holding stand legs to the chassis-holding stand base (Figure 7-30).

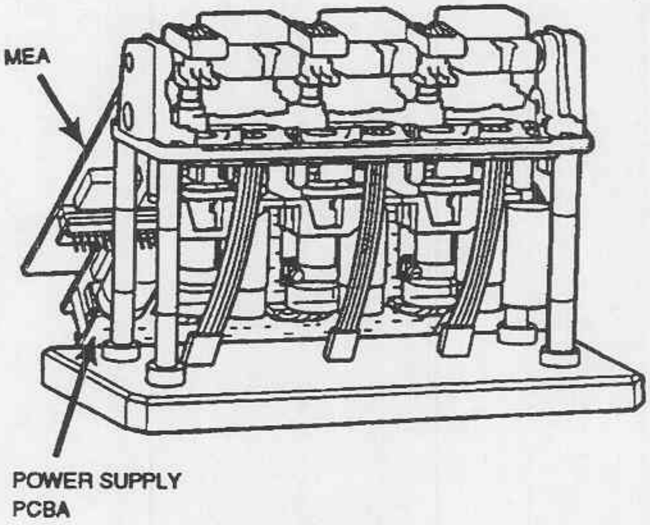
Figure 7-30. Assembly of Chassis Holding Stand



c. MEA Removal

1. Carefully lift the MEA, which has the power supply PCBA attached to it, from the chassis guides. Place the chassis on the chassis holding stand with the drive modules facing down. Position the MEA, which has the power supply PCBA attached, away from the chassis stand so that it allows for correct placement of the chassis (see Figure 7-31).

Figure 7-31. Attachment of Chassis to Holding Stand



d. Loosen the air-in-line sensor module.

1. Remove the two air-in-line sensor mounting screws, using the 5/64-inch ball-end hex driver or T-6 Torx driver, as appropriate (Figure 7-32).

e. Remove the pump latch assembly.

1. First remove the locking set screw on the back of the latch assembly, using a 0.05-inch hex driver (Figure 7-33).
2. Next, loosen the inner locking set screw.
3. Lift the pump latch assembly off the pump shaft.

Figure 7-32. Air-in-line Sensor Mounting Screws

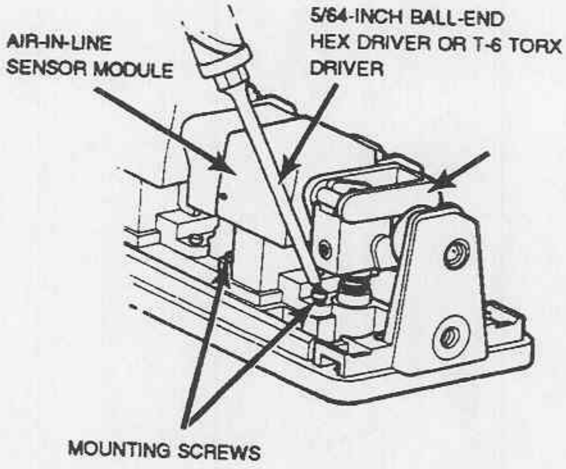
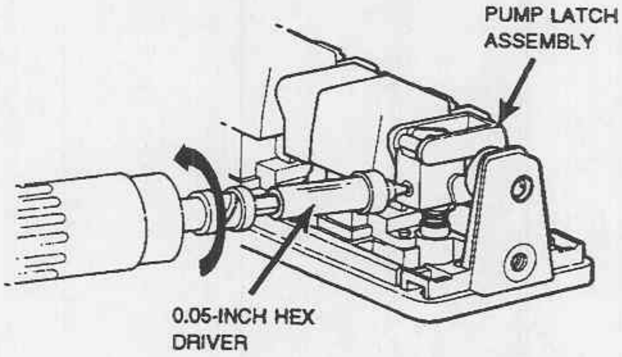

AIR-IN-LINE SENSOR MODULE
5/64-INCH BALL-END HEX DRIVER OR T-6 TORX DRIVER
MOUNTING SCREWS

Figure 7-33. Locking Set Screw Removal


PUMP LATCH ASSEMBLY
0.05-INCH HEX DRIVER

f. Inspect for the following.
   1. Pump shaft seal damage (remove the pump shaft seal before inspecting).
   2. Dirt and dried solution on the shaft or sleeve bearing under the seal.
   3. Loose pump shaft sleeve bearings (machined aluminum chassis only).
   4. Impaired slide link movement.
   5. Slide link reflector surface damage.

Reassembly

g. Install the pump shaft seal.
   1. The pump shaft seal may have a short and long end. If so, the shorter end points toward the chassis (Figure 7-34).

h. Install the pump latch assembly.
   1. Position the slide link to allow insertion of the movable jaw pin into the slide link slot (see Figure 7-35).

Figure 7-34. Ends of Pump Shaft Seal

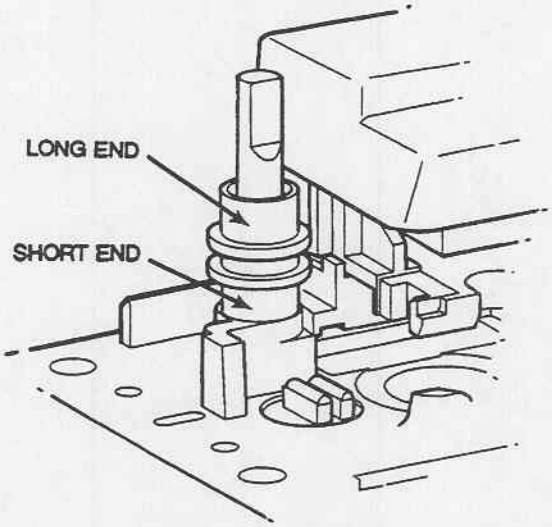
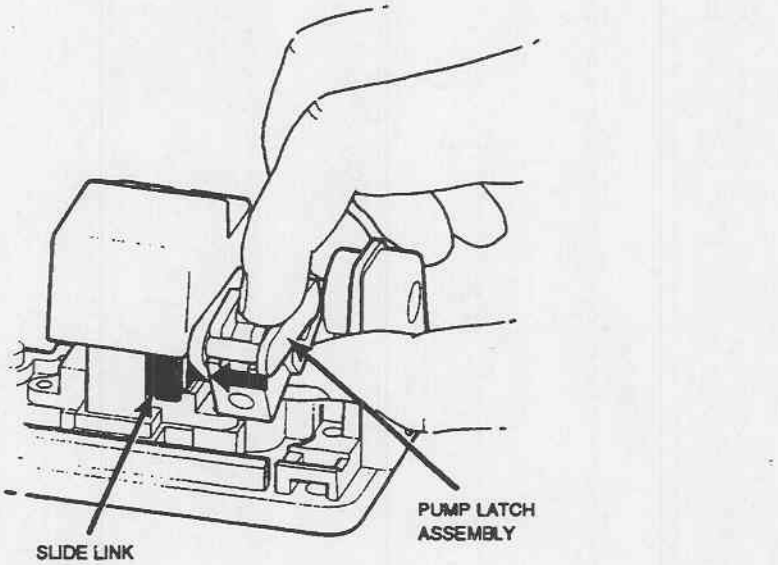

LONG END
SHORT END

Figure 7-35. Insertion of Movable Jaw Pin into Slide Link Slot

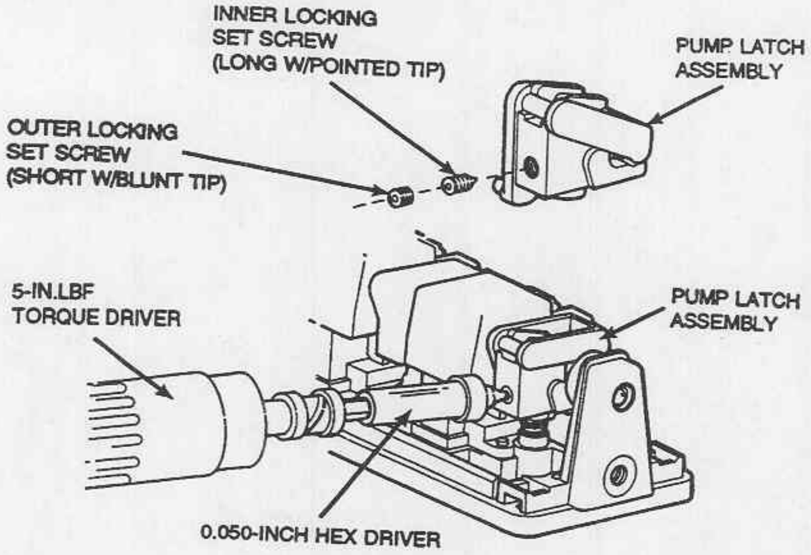

PUMP LATCH ASSEMBLY
SLIDE LINK

2. Mount the pump latch assembly on the pump shaft. Lightly tighten the inner locking set screw, using a 0.50-inch hex driver (Figure 7-36).

i. Install the air-in-line sensor mounting screws, using a 5/64-inch ball-end hex driver or T6-Torx driver. Tighten to 3 in. lbf.

j. Adjust the pump latch height (Section 7.3.2).

Figure 7-36. Tightening of Locking Screws


INNER LOCKING SET SCREW (LONG W/POINTED TIP)
PUMP LATCH ASSEMBLY
OUTER LOCKING SET SCREW (SHORT W/BLUNT TIP)
5-IN.LBF TORQUE DRIVER
PUMP LATCH ASSEMBLY
0.050-INCH HEX DRIVER

k. Reassemble the following in the order listed.
   1. Pole clamp (Section 7.2.1).
   2. MEA (Section 7.5.1).
   3. Backup battery to locking two-pin connector (Section 7.5.3).
   4. Ground wire to chassis (Section 7.5.5).
   5. Display module (Section 7.5.2).
   6. Main housing assembly (Section 7.1.3).
   7. Battery pack (Section 7.1.2).
   8. Lower housing assembly (Section 7.1.1).

l. Recalibrate the sensor systems.
   1. Recalibrate all the sensor systems (Chapter Five).

m. Test.
   1. Perform run-in (Section 7.1) and all the functional checks (Chapter Three) except for the battery check.

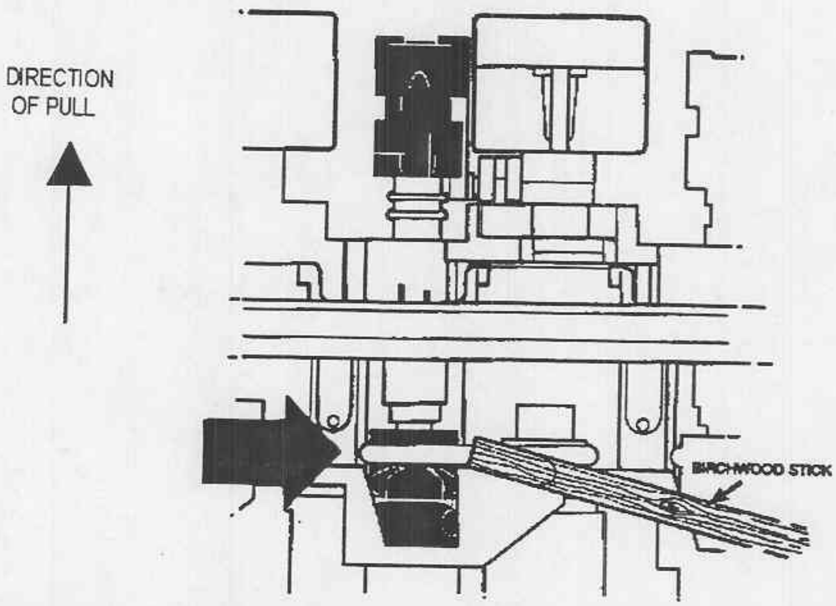
n. Restore the settings.
   1. Using FMS, restore the customized settings and the Battery History Log (refer to the FMS Directions For Use).

7.3.2 Pump Latch Height Adjustment

NOTE: *Gauge blocks are precision instruments. Before they are used, they should be clean and free of any debris. Clean using a lint-free cloth moistened with isopropyl alcohol.*

1. If the instrument is disassembled, rotate each cam until the pump latch assembly is at the closest position to the chassis (Figure 7-37). If the instrument is assembled, remove the lower housing and place the instrument in an upside down vertical position and turn it on. This will *Home* each channel. Pull the pump latch assembly so that the left actuator is switched to the **highest** position (Figure 7-37). Then slowly push down on the pump latch assembly until it stops, without changing the left actuator position. Turn off the instrument.

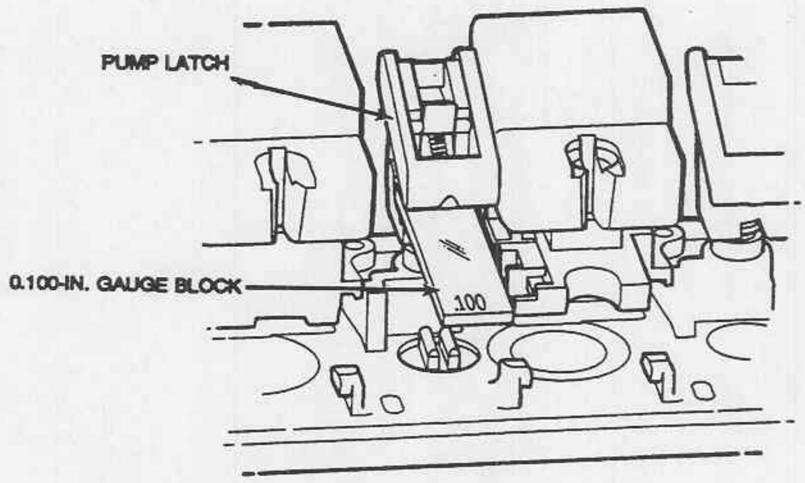
Figure 7-37. Latch Assembly Position Closest to Chassis



NOTE: *When rotating the cam, do not touch with the fingers; use a birchwood stick. Ensure that grease does not come in contact with the belt.*

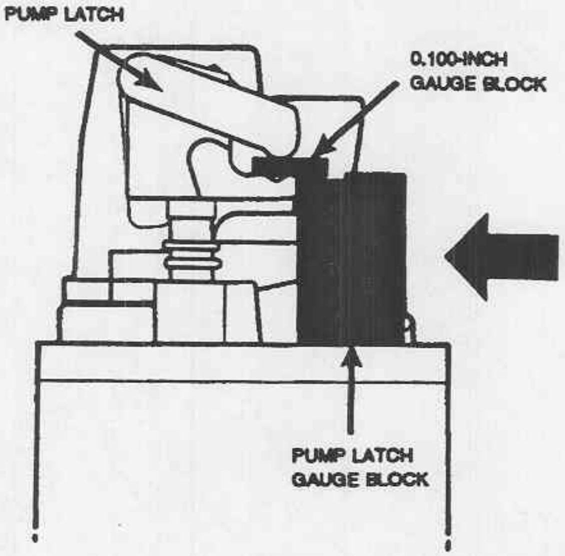
2. Place the 0.100-inch gauge block between the pump latch jaws (Figure 7-38) and close the jaws.

Figure 7-38. Positioning of the 0.100-inch Gauge Block



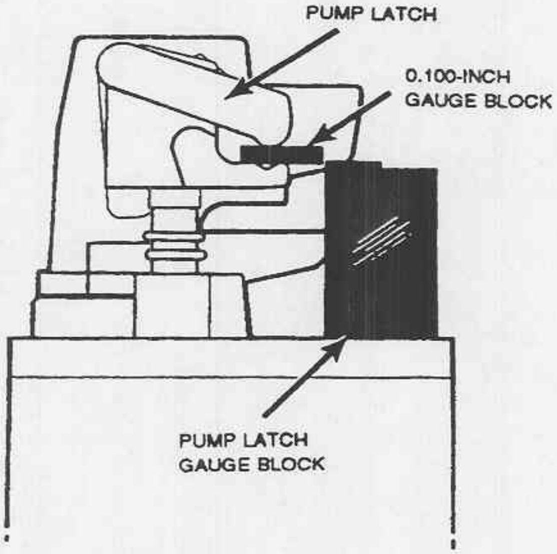
3. Place the pump latch gauge block on the chassis. Ensure that the ridge on the gauge block is on top.
4. Slide the **low** side of the pump latch gauge block under the 0.100-inch gauge block. Stop if any interference is felt, as the pump latch height must be adjusted (Figure 7-39).

Figure 7-39. Low Side of Pump Latch under 0.100-inch Gauge Block


PUMP LATCH
0.100-INCH GAUGE BLOCK
PUMP LATCH GAUGE BLOCK

5. Turn the pump latch gauge block around and slide the **high** side of the pump latch gauge block toward the 0.100-inch gauge block. Stop if any interference is felt, as the pump latch height must be adjusted (Figure 7-40).

Figure 7-40. High Side of Pump Latch under 0.100-inch Gauge Block


PUMP LATCH
0.100-INCH GAUGE BLOCK
PUMP LATCH GAUGE BLOCK

NOTE: *Gauge blocks dimensions should be verified annually to ensure optimum performance. The distance between the bottom and the* ***low*** *side of the pump latch gauge block is 0.7580 + 0.0004 or - 0.0000 inches. The distance between the bottom and the* ***high*** *side of the pump latch gauge block is 0.7620 + 0.0000 or - 0.0004 inches. If dimensions are incorrect, the gauge blocks should be replaced.*

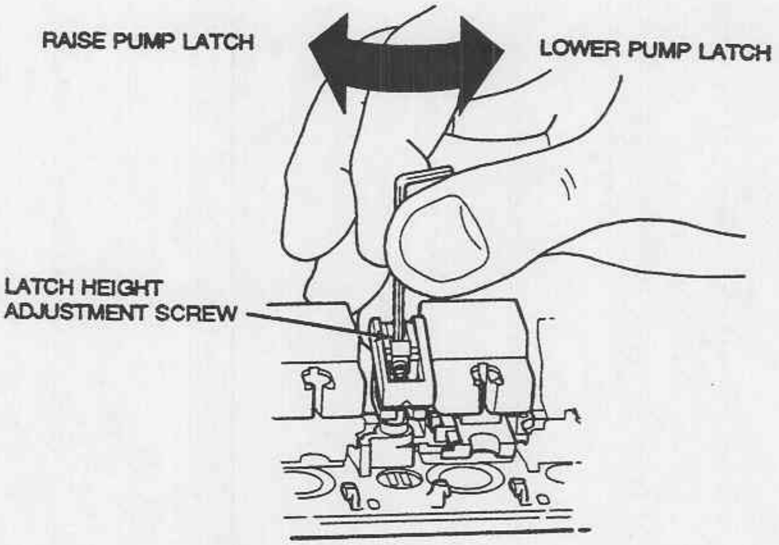
6. The following table shows the gauge conditions that indicate whether or not the pump latch height is within specification.

Table 7-1. Gauge Conditions for Pump Latch Height Specifications

(Low Side) Minimum	(High Side) Maximum	Within Specification
Go	Stop	Yes
Go	Go	No
Stop	Stop	No

7. If the pump latch height is not within specification, use the 0.050-inch Allen key to turn the height adjustment screw on the latch (Figure 7-41). This screw raises (turned clockwise) or lowers (turned counterclockwise) the pump latch.

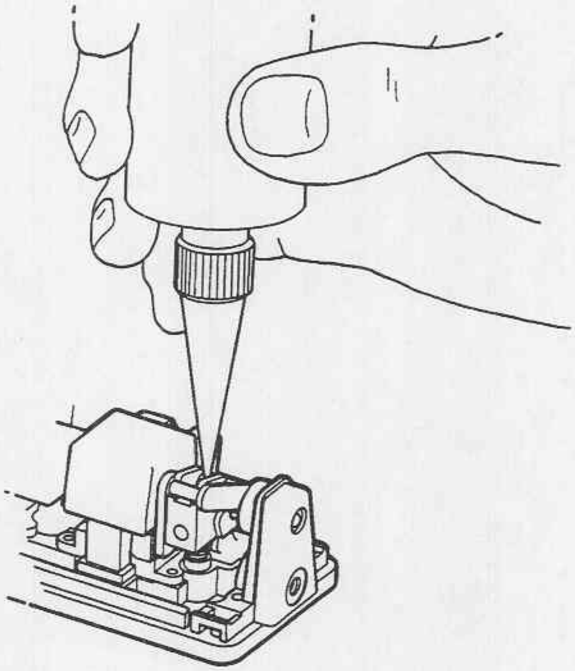
Figure 7-41. Latch Height Adjustment Screw



8. Repeat the procedure and adjustment until the height is within specification.
9. Tighten the inner locking set screw to 5 in. lbf, using the 0.05-inch hex driver (Figure 7-36).
10. Install the outer locking set screw and tighten to 5 in. lbf (Figure 7-36).
11. Apply a small drop of Loctite® Assure 425 to the latch height adjustment screw (Figure 7-42). Take care not to drip excess adhesive on any other parts.

NOTE: *Use only Loctite Assure 425 on the pump latch height adjustment screw. Do not substitute other agents, as they can damage the plastic components. Do not use the threadlocker in any other location.*

Figure 7-42. **Loctite Assure 425 Application**



7.3.3 Pump Latch Movable Jaw Repair

Tools required:

- Small flat blade screwdriver
- Tweezers

Disassembly

a. First, remove the following.

    1. Lower housing assembly (Section 7.1.1).

b. Remove the movable jaw, spring, and seat.

Attach the instrument firmly to a table and rotate it until the pump latches are facing up. *Home* the pump latch by turning the instrument on with no cassette installed. The latch should now be in the closest position to the chassis. Turn the instrument off.

1. Close the pump latch movable jaw (Figure 7-43).
2. Insert a small screwdriver under the pivot bar on the upper rear part of the movable jaw (Figure 7-44).
3. Slowly pry the pivot bar up and back to clear the stationary jaw.

Figure 7-43. Pump Latch Movable Jaw Closure

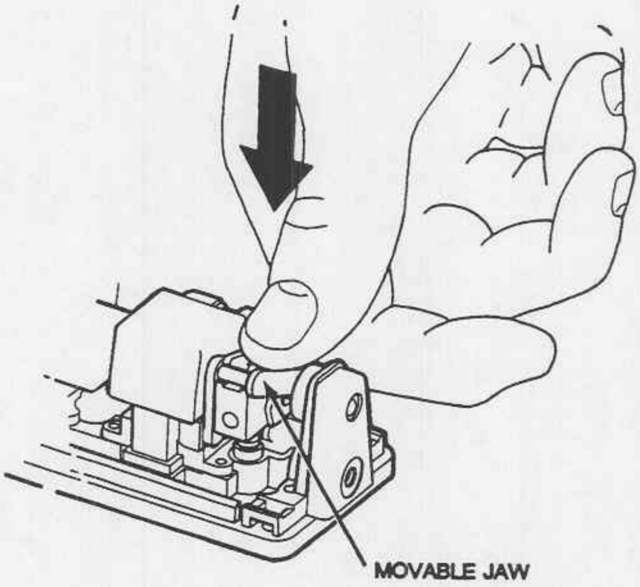
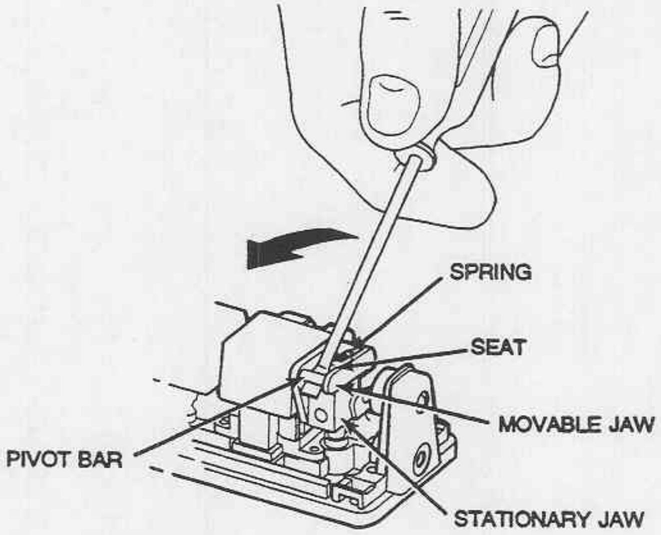
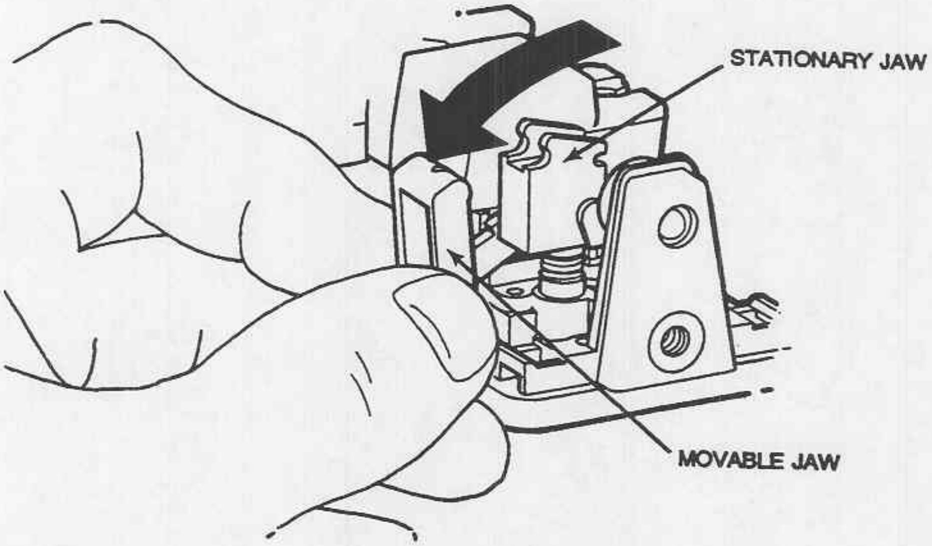

MOVABLE JAW

Figure 7-44. Movable Jaw Separation


SPRING
SEAT
MOVABLE JAW
PIVOT BAR
STATIONARY JAW

4. Using tweezers, remove the spring and seat.
5. Rotate the movable jaw back 90 degrees to clear the stationary jaw (Figure 7-45).
6. Slide the movable jaw to the side away from the pump latch, using a slight twisting motion to release it from the slide link.

Figure 7-45. Movable Jaw Removal

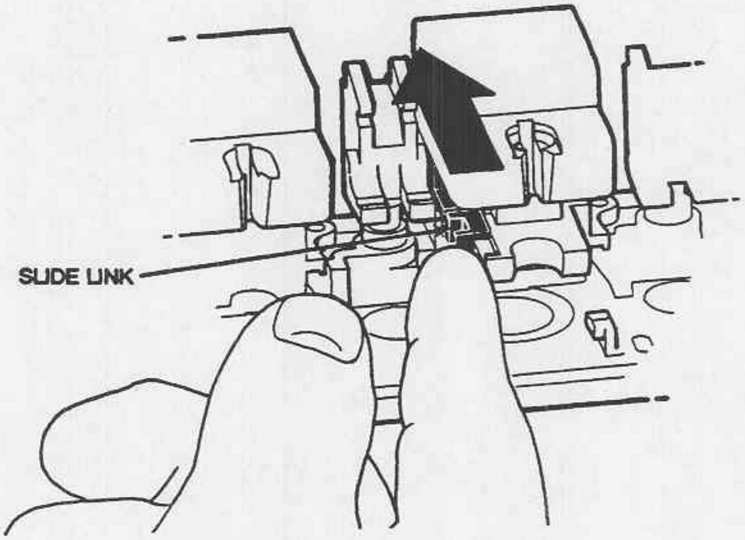

STATIONARY JAW
MOVABLE JAW

Reassembly

a. Reassemble the movable jaw, spring, and seat.

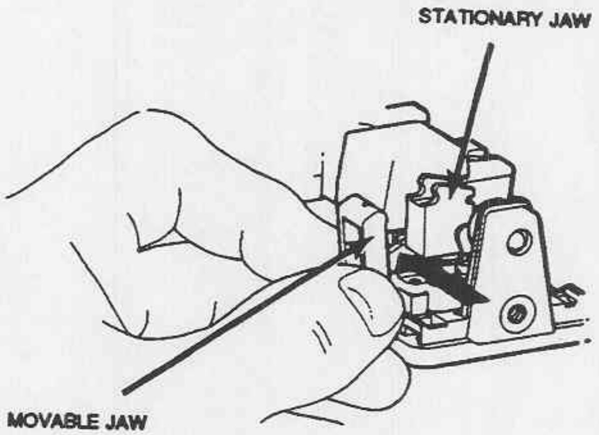
   1. Position the slide link all the way to the rear of the instrument (Figure 7-46).

Figure 7-46. Slide Link Position for Movable Jaw Reassembly



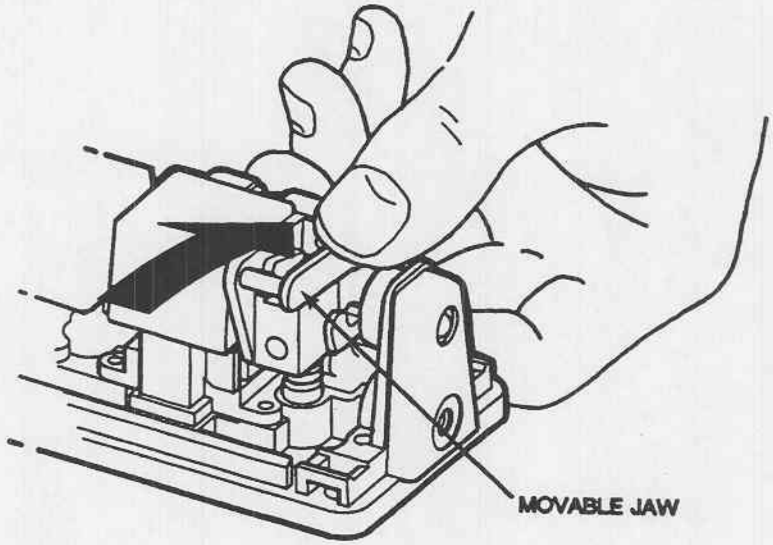
2. Insert the movable jaw pin into the slide link slot (Figure 7-47).

Figure 7-47. ***Movable Jaw Pin Insertion***



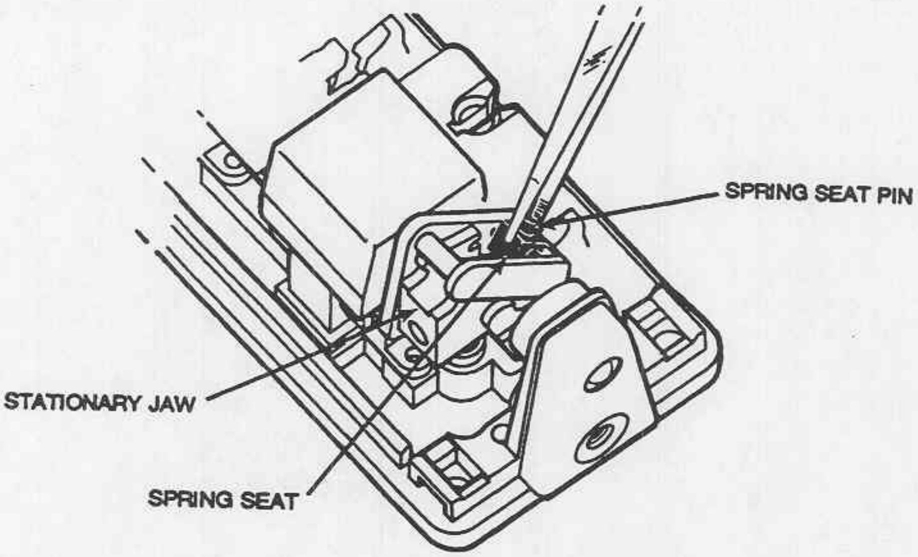
3. Rotate the movable jaw to the lowest position (Figure 7-48).

Figure 7-48. ***Movable Jaw Rotation for Reassembly***



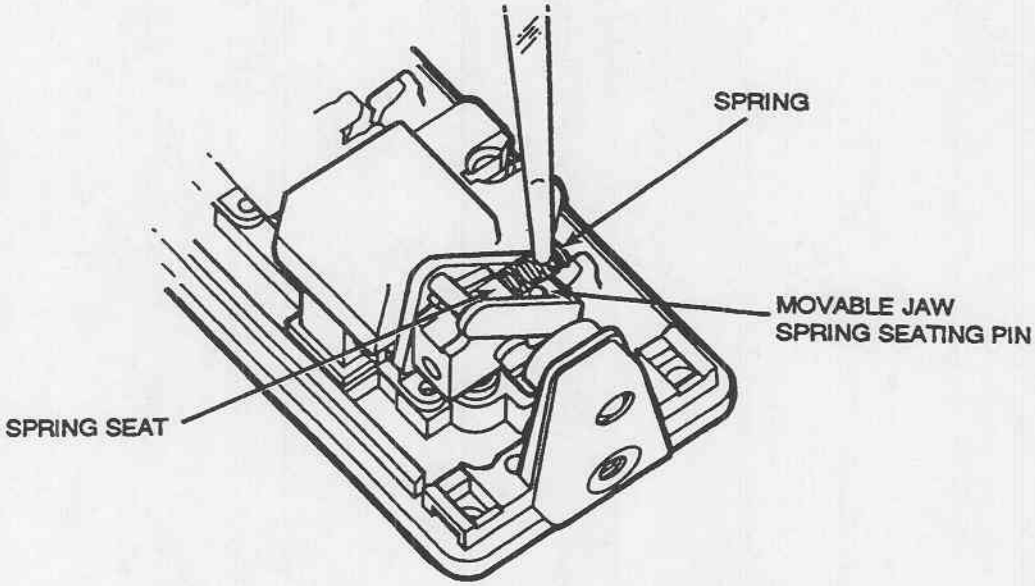
4. Install the spring seat onto the stationary jaw (Figure 7-49) so that the angled portion of the seat faces the chassis and the spring seat pin points forward.

Figure 7-49. Spring Seat Installation


SPRING SEAT PIN
STATIONARY JAW
SPRING SEAT

5. Using tweezers, place the spring over the seat pin (Figure 7-50).

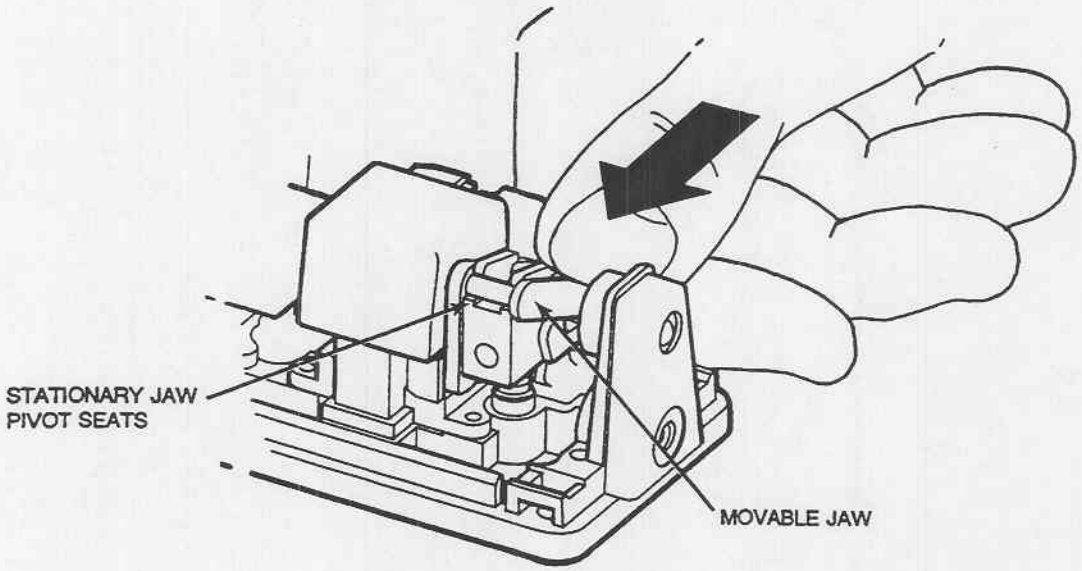
Figure 7-50. Latch Assembly Spring Placement


SPRING
MOVABLE JAW
SPRING SEATING PIN
SPRING SEAT

6. Position the movable jaw spring seating pin against the spring.

7. Compressing the spring, rotate the movable jaw into the stationary jaw pivot seats (Figure 7-51).

Figure 7-51. ***Spring Compression and Movable Jaw Rotation***



b. Check the following.
   1. Turn the instrument on.
   2. Open and close the movable jaw to ensure proper operation of the latch and slide link.
   3. Verify that the software recognizes latch closure. Check for *Closed Pump Latch* advisory.
   4. Leave the pump latch in the open position.

c. Reattach the lower housing assembly (Section 7.1.1).

7.3.4 Slide Link Repair

Tools required:

- 5/64-inch ball-end hex driver or T-6 Torx driver
- 3 in. lþ torque driver
- Small flat blade screwdriver
- Tweezers

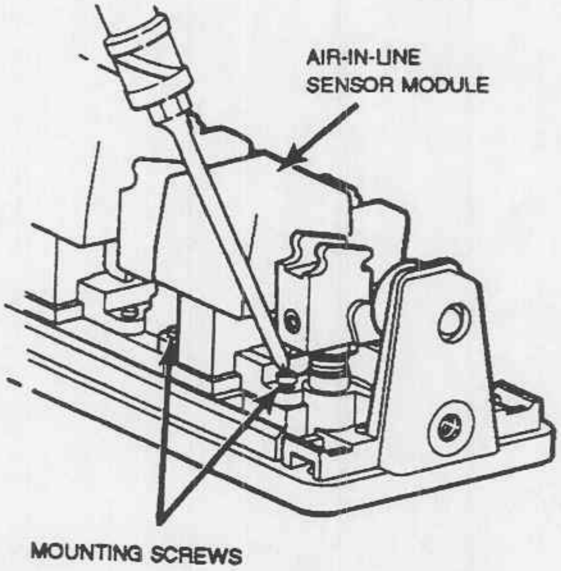
Disassembly

a. First, remove the following.
   1. Lower housing assembly (see Section 7.1.1).
   2. Pump latch movable jaw (Section 7.3.3).

   Remove the slide link:

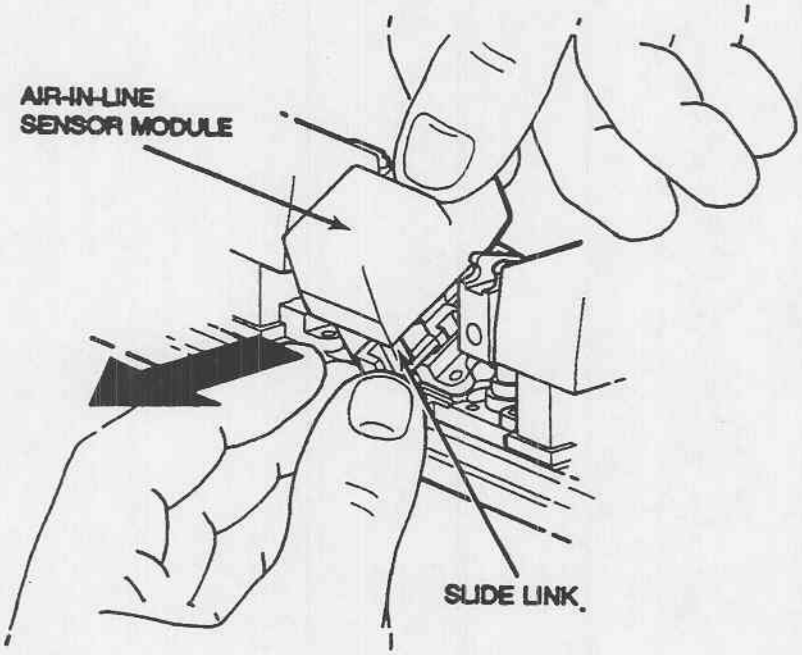
   (a) Loosen the air-in-line sensor mounting screws with the 5/64-inch ball-end hex driver or the T6-Torx driver, as appropriate (Figure 7-52).

Figure 7-52. Air-in-line Sensor Mounting Screws


AIR-IN-LINE
SENSOR MODULE
MOUNTING SCREWS

(b) Slightly lift the sensor module so that the slide link clears the optomodule (Figure 7-53).

Figure 7-53. Slide Link Removal


AIR-IN-LINE
SENSOR MODULE
SLIDE LINK

(c) Be careful not to disconnect the air-in-line sensor module from the MEA by lifting too far.

(d) Remove the slide link toward the rear of the instrument.

CAUTION

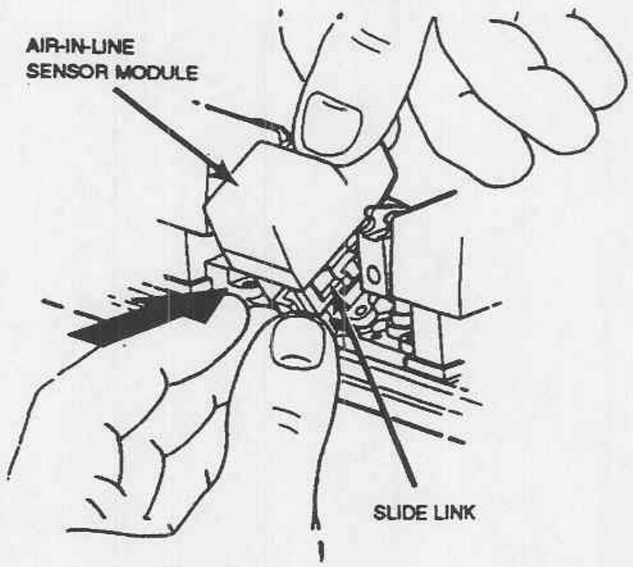
Do not touch the reflective surface on the bottom of the slide link, as skin oils may contaminate the surface. The slide link track requires NO lubrication.

b. Inspect for the following.
   1. Defects, dried solution, or dirt on the reflector surface.
   2. Dried solution and dirt on the optomodule and air-in-line sensor.

Reassembly

a. Reinstall the slide link.
   1. Insert the slide link (Figure 7-54) into place by tilting the air-in-line sensor module to clear the optomodule.
   2. Slide the slide link forward to ensure proper movement on the track.

Figure 7-54. Slide Link Replacement



   3. Tighten the air-in-line sensor mounting screws to 3 in. lbf, using the 5/64-inch ball-end hex driver or T-6 Torx driver.
   4. Reassemble the movable jaw, spring, and seat (Section 7.3.1).
   5. Reattach the lower housing assembly (Section 7.1.1).

b. Recalibrate the cassette and latch sensors (Chapter 5).

c. Test.
   1. Perform run-in (Section 7.1) and all the functional checks (Chapter 3) except for the battery.

7.3.5 Drive Module Assembly Repair

WARNING

Whenever the drive module is removed and reinstalled, the valve actuator and pump latch height must be verified and, if necessary, adjusted. This is a critical step and must be performed to ensure safety, as well as proper functioning of the instrument.

Tools required:

- #1 Phillips screwdriver
- 3/32-inch hex driver
- 5/16-inch flat blade screwdriver
- Chassis holding stand
- 0.05-inch Allen key
- 0.05-inch hex driver
- 5 in. lbf torque driver
- Lint-free swabs
- Magnalube-G Teflon grease
- Loctite® Assure 425 surface curing threadlocker
- Gauge block kit

Disassembly

a. First, remove the following.

   1. Lower housing assembly (Section 7.1.1).
   2. Battery pack (Section 7.1.2).
   3. Main housing assembly (Section 7.1.3).
   4. Display module (Section 7.5.2).
   5. Pole clamp assembly (Section 7.2.1).
   6. Ground wire from the chassis (Section 7.5.5).
   7. Backup battery from the locking two-pin connector (Section 7.5.3).
   8. All motor, encoder, and pressure transducer connections from the MEA (Section 7.4.2).

b. Remove the drive module assembly.

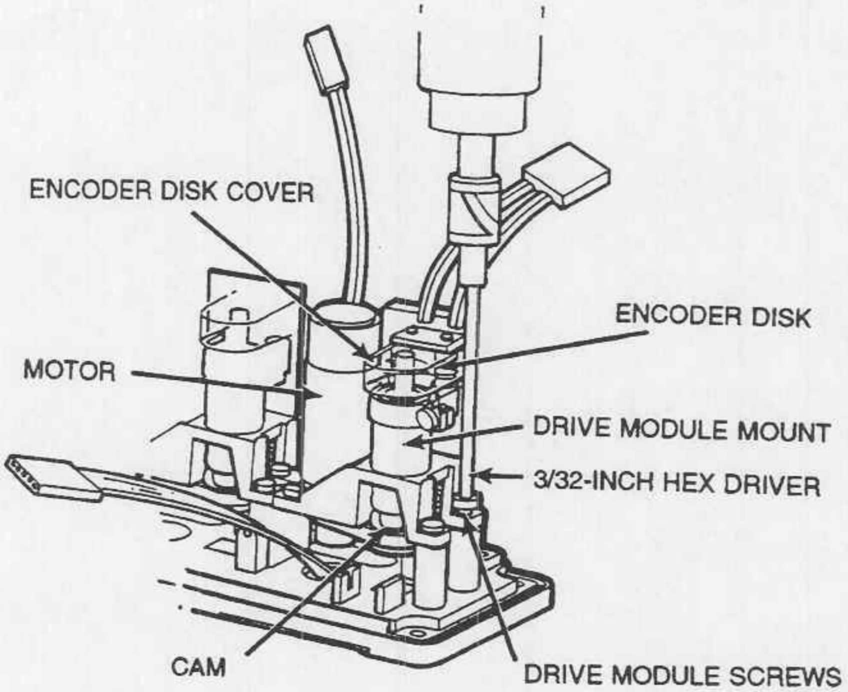
   1. Remove the three drive module mounting screws, using a 3/32-inch hex driver (Figure 7-55).

   NOTE: *Ensure the belt and pulleys aren't contaminated with grease or skin oils.*

c. Inspect for:

   1. Drive belt that is worn, cracked or contaminated with grease.
   2. Broken wires or connectors.
   3. Damaged encoder disk or disk cover (Figure 7-55).
   4. Cracked or broken drive module mounts.
   5. Pump shaft bearing not seated (Model 2860 only).
   6. Corrosion.

Figure 7-55. Drive Module Screw Removal



d. Ensure the following.
   1. The motor is secured firmly to drive module.
   2. The cam is secured firmly.

> **WARNING**
>
> *The alignment of the cam to the encoder is critical for proper fluid delivery; therefore, do not repair defective modules. Defective modules must be replaced. (The motor can be replaced and is part of the module.)*

   3. The motor and cam turn freely in one direction (remove the drive belt to test).
   4. The one-way clutch within the drive module assembly allows cam rotation in only one direction.

Reassembly

a. Replace the motor.
   1. Remove the drive belt (see Figure 7-56).
   2. Loosen the motor mounting screws that retain the motor, using the #1 Phillips and flat blade screwdrivers (Figure 7-57).
   3. Rotate the cleats so that the "flats" face the motor (Figure 7-58).
   4. Noting orientation (Figure 7-58), remove and replace the motor.
   5. Rotate the cleats to the previous locking position.

Figure 7-56. **Drive Belt Removal**

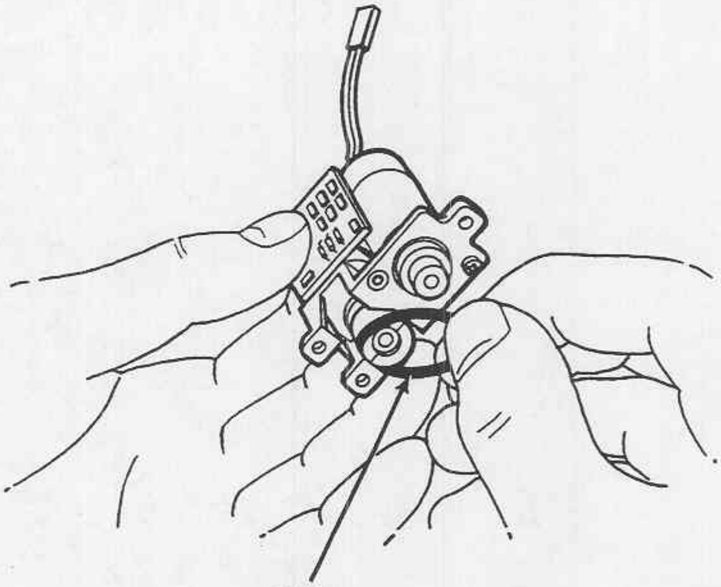
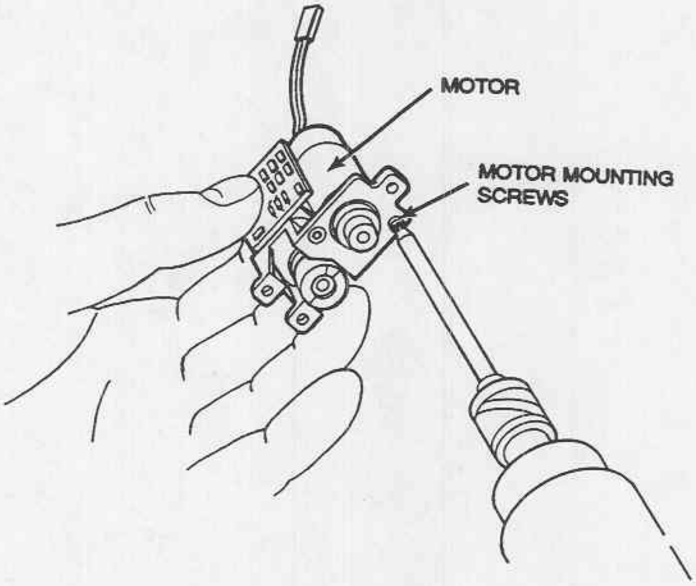
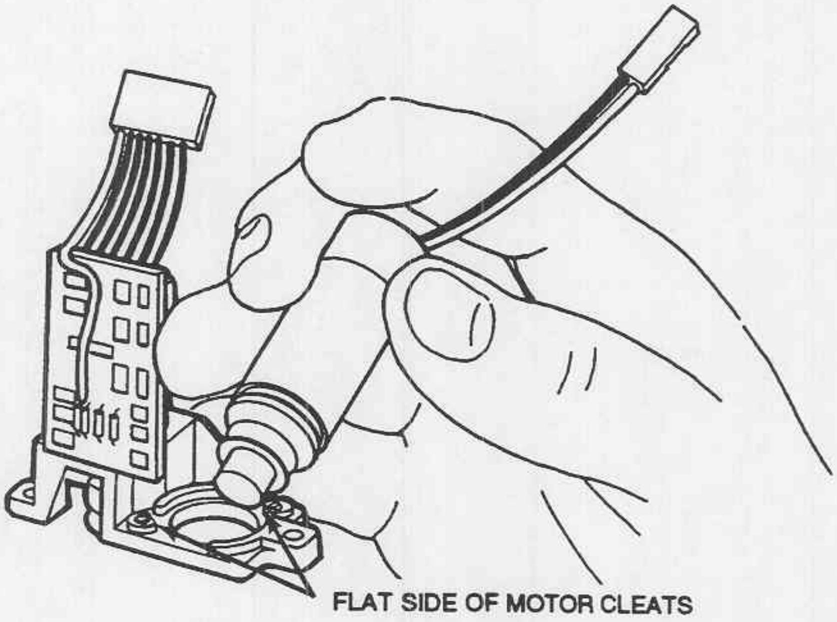


Figure 7-57. **Motor Mounting Screws**


MOTOR
MOTOR MOUNTING SCREWS

6. Tighten the mounting screws.
7. Attach the drive belt.

Figure 7-58. Motor Cleat Rotation



b. Replace the encoder or motor connector/wires.
   1. A Connector Kit, which can be ordered, contains the required encoder and motor connector shells, and wires crimped with receptacles.
   2. If heat shrink tubing is used to repair wires, do not apply direct heat to the drive module assembly. The assembly can be easily damaged.
   3. If the wires are resoldered to the encoder, be sure to reapply epoxy around the solder pads.
   4. The epoxy acts as a strain relief and helps prevent the wires from breaking (see Figure 7-59).
   5. Ensure that the replacement wire is the proper length.
   6. Ensure the proper orientation of the connector and wires during replacement (see Figure 7-59).

c. Clean and lubricate the cam.

   NOTE: *Be sure that the belt and pulleys are not contaminated with grease or skin oils.*

   1. Using a lint-free swab and isopropyl alcohol, clean the surface of the cam that contacts the valve actuator bearings (Figure 7-60). Clean the slot in the cam that drives the pump shaft follower. Also, clean the pump shaft follower bearings and the valve actuator bearings (Figure 7-60).
   2. Using a clean lint-free swab, apply a thin film of Magnalube-G Teflon grease to the cam face and slot.

Figure 7-59. **Drive Module Assembly Wire Orientation**

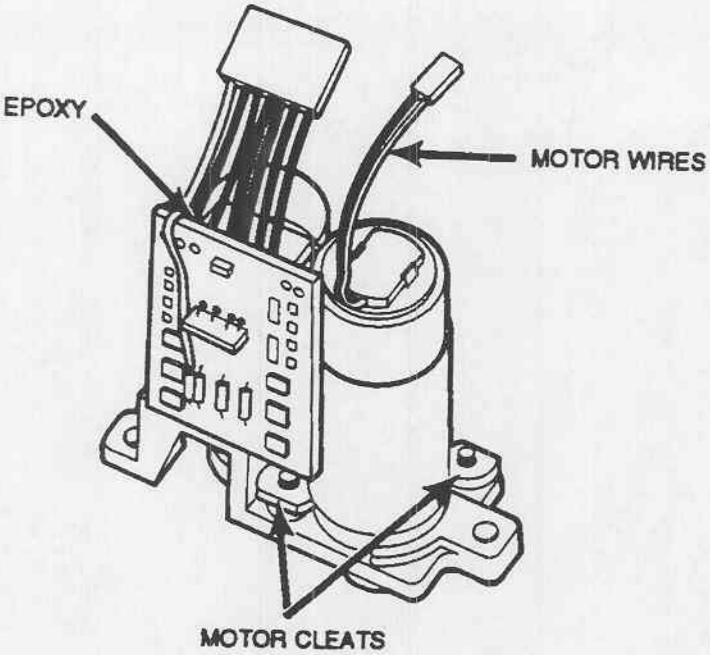
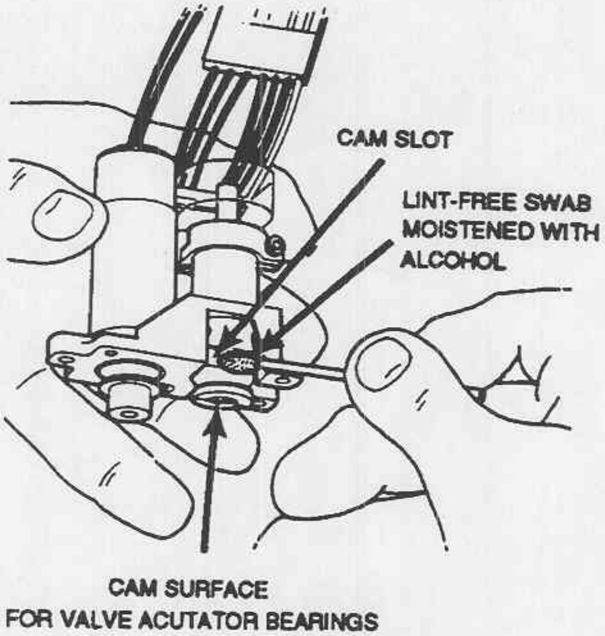
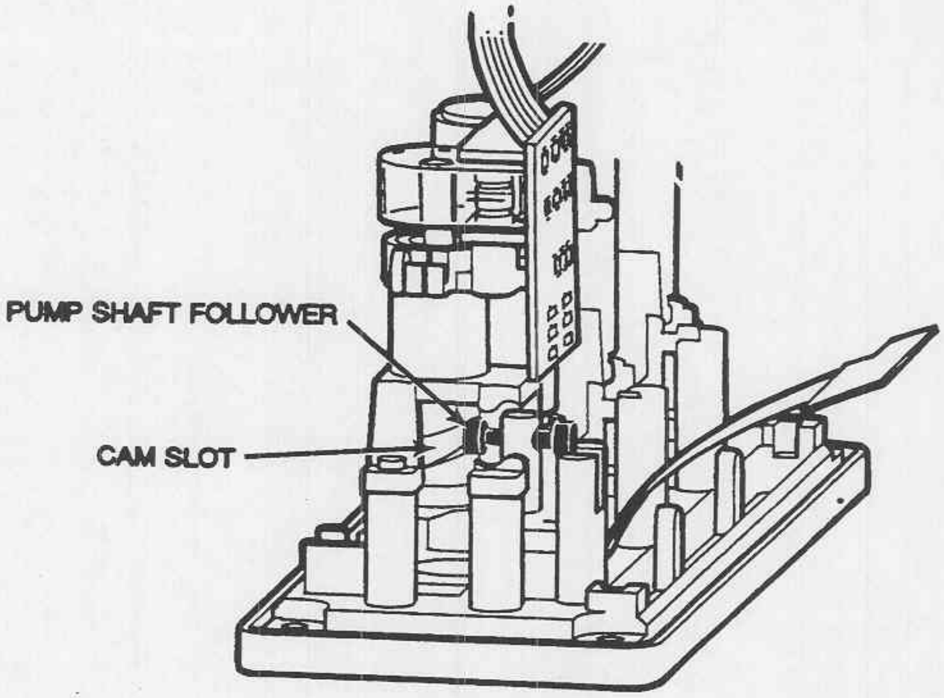

EPOXY
MOTOR WIRES
MOTOR CLEATS

Figure 7-60. **Cleaning the Cam**


CAM SLOT
LINT-FREE SWAB
MOISTENED WITH
ALCOHOL
CAM SURFACE
FOR VALVE ACUTATOR BEARINGS

3. Ensure that the motor wires are oriented toward the rear of the drive module (Figure 7-59). If not, loosen the motor screws and realign.
4. Align the pump shaft cam follower with the cam slot (Figure 7-61).

Figure 7-61. Pump Shaft Cam Follower Adjustment



5. Position the drive module on the chassis.
6. Install the drive module mounting screws, using a 3/32-inch hex driver or a #1 Phillips screwdriver, as appropriate. Tighten to 5 in. lbf torque.

> **WARNING**
>
> *If any chassis threads are stripped, do not attempt to repair them. The chassis must be replaced. Free-flow or inaccurate fluid delivery can result from a drive module that is not properly secured. Should chassis replacement be necessary, return the instrument to the factory for repair.*

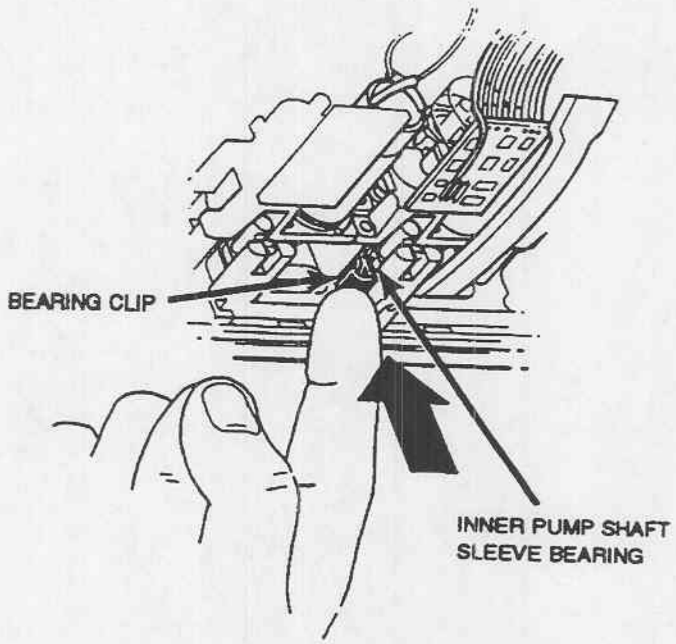
7. For Model 2860, install bearing clips to retain the inner pump shaft sleeve bearing (Figure 7-62). Make sure that the clips are properly installed. One loud, then one soft, click should be heard as clips are pushed in; and clips should be immobile.

   NOTE: *Do not reuse bearing clips.*

d. Ensure the following.

1. The assembly operates by applying 5VDC (9mA minimum) power to the motor terminals.
2. Connect the positive to the red wire; otherwise, the one-way clutch will prevent movement.

Figure 7-62. ***Bearing Clip Installation (Model 2860 only)***



e. Verify the valve actuator heights using the procedure described in Section 7.3.6.

f. Adjust the pump latch height.

   1. Adjust the pump latch height using the procedure described in Section 7.3.2.

Reassembly

a. Reassemble in the following order.

   1. Pole clamp (Section 7.2.1).
   2. MEA (Section 7.5.1).
   3. Backup battery to locking two-pin connector (Section 7.5.3).
   4. Ground wire to chassis (Section 7.5.5).
   5. Display module (Section 7.5.2).
   6. Main housing assembly (Section 7.1.3).
   7. Battery pack (Section 7.1.2).
   8. Lower housing assembly (Section 7.1.1).

b. Recalibrate.

   1. All the sensor systems must be recalibrated (Chapter 5).

c. Test.

   1. Perform run-in (Section 7.1) and all the functional checks.

d. Restore the settings.

   1. Using FMS, restore the customized settings and the Battery History Log. (Refer to the FMS Directions For Use.)

7.3.6 Valve Actuator Height Verification

NOTE: *Gauge blocks are precision instruments. Before they are used, they should be clean and free of any debris. Clean using a lint-free cloth moistened with isopropyl alcohol.*

a. Assemble the chassis holding stand (Section 7.1).

b. Remove the pole clamp. Carefully lift the MEA, which has the power supply PCBA attached to it, from the chassis guides. Attach the chassis to the chassis holding stand with the drive modules facing down. Position the MEA and attached power supply PCBA away from the chassis stand so that it allows for correct placement of the chassis (Figure 7-63).

c. Rotate each cam until the right valve actuator is at the highest position above the chassis (Figure 7-64).

d. If the instrument is assembled, place it in an upside-down, vertical position and turn it on. This will "Home" each channel and place the right valve actuators at the highest position (Figure 7-64). Turn the instrument off.

e. Place the valve actuator gauge block, marked MIN, on the chassis in front of the valve actuators. Make sure that the high side of the gauge aligns with the high valve actuator (Figure 7-65).

f. Move the valve actuator gauge block so that it rests along the cassette guide.

g. Gently slide the valve actuator gauge block along the chassis toward the pump shaft until:

    1. it slides over the valve actuators, or
    2. interference is felt when the valve actuator gauge block comes in contact with the valve actuators.

h. Repeat the steps with the valve actuator gauge block marked MAX.

i. The following table shows the gauge conditions that indicate whether or not the valve actuator heights are within specification.

Table 7-2. Gauge Conditions for Valve Actuator Height Specifications

(Low Side) Minimum	(High Side) Maximum	Within Specification
Stop	Go	Yes
Go	Go	No
Stop	Stop	No

NOTE: *The distance (in inches) between the bottom and each side of the minimum and maximum valve actuator gauge block is as follows.*

Figure 7-63. Attachment of Chassis to Holding Stand

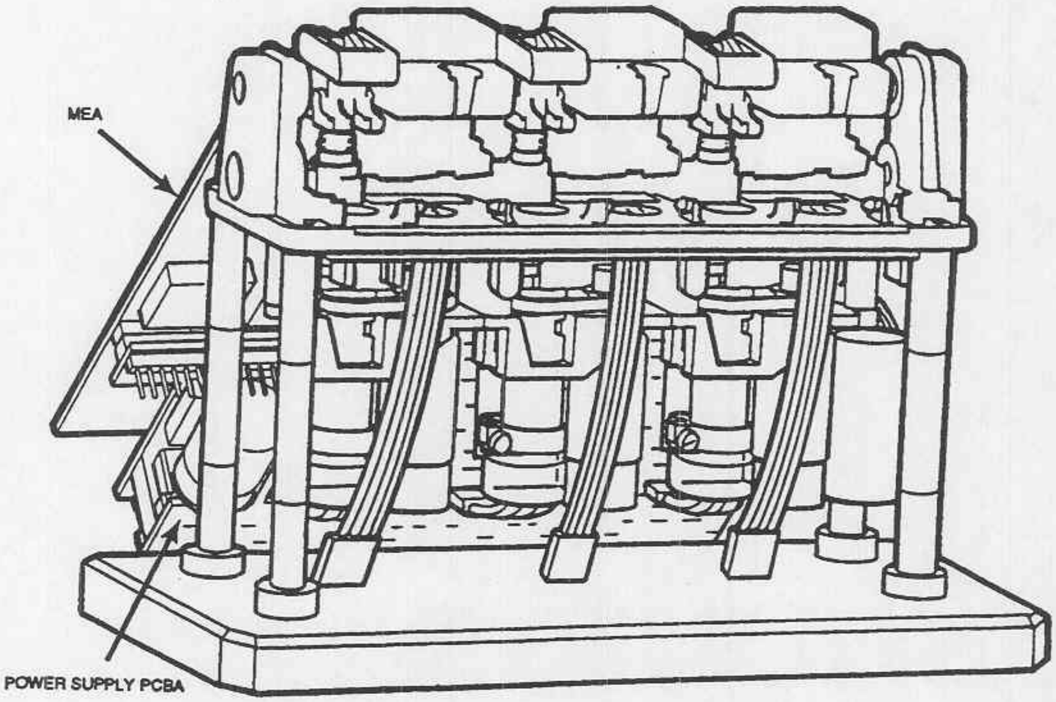
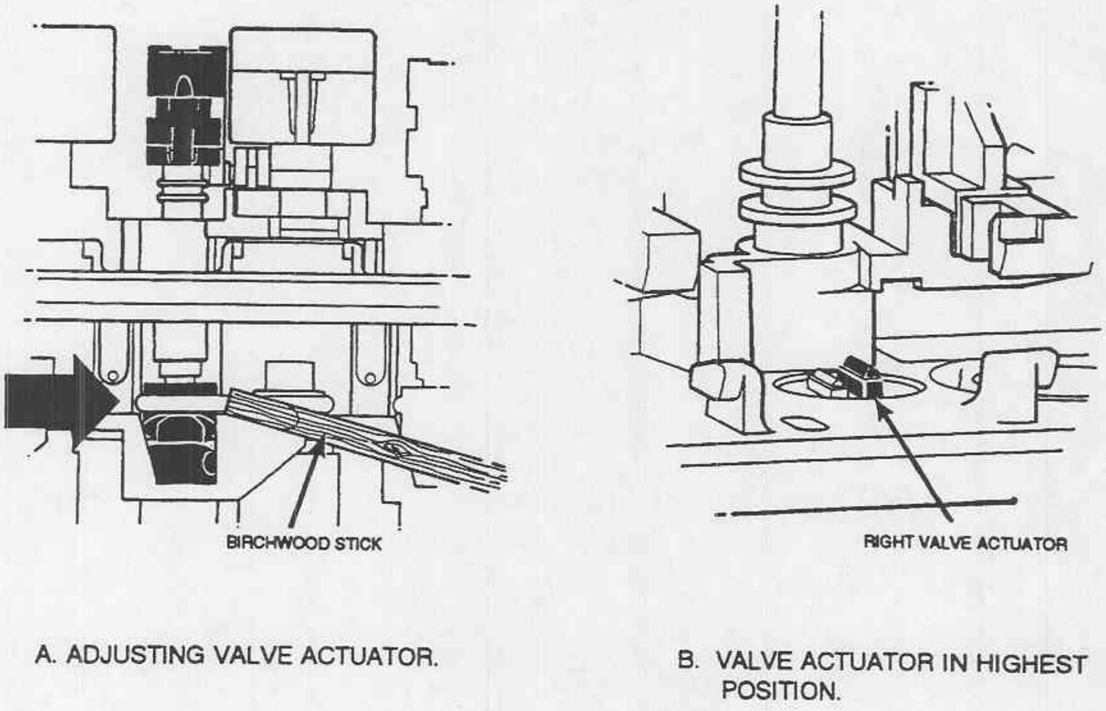

MEA
POWER SUPPLY PCBA

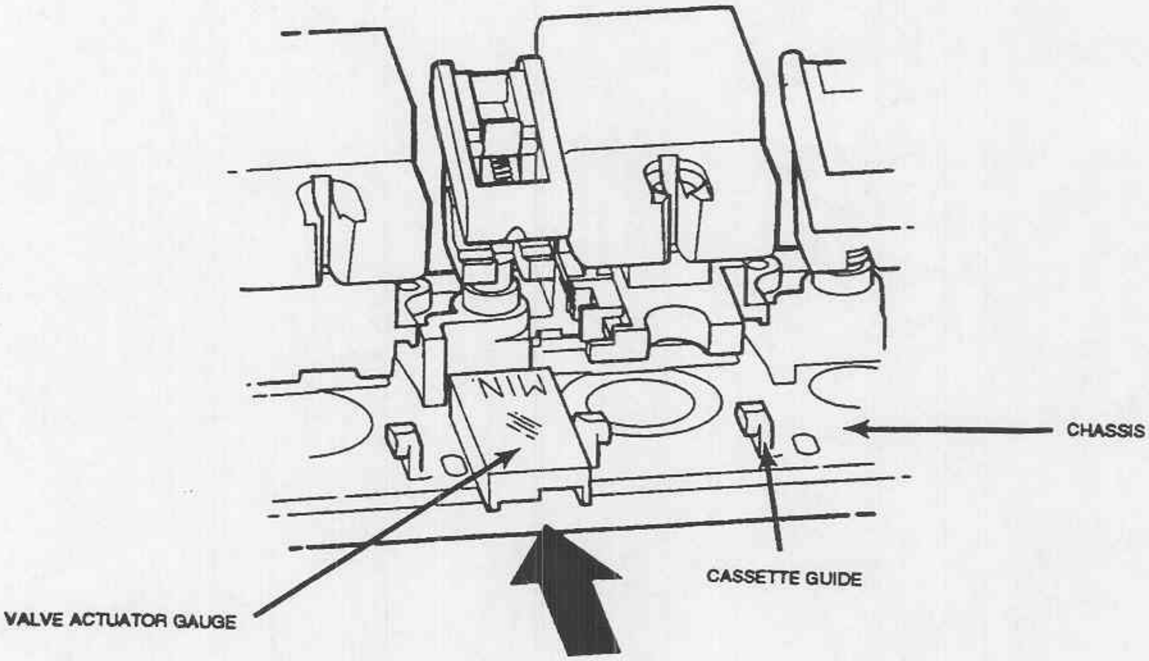
Figure 7-64. Right Valve Actuator at Highest Position


BIRCHWOOD STICK
RIGHT VALVE ACTUATOR

A. ADJUSTING VALVE ACTUATOR.

B. VALVE ACTUATOR IN HIGHEST POSITION.

Figure 7-65. Placement of Valve Actuator Gauge Block on Chassis



Bottom to High Side:
Minimum is 0.0700 + 0.0000 / - 0.0005
Maximum is 0.0750 + 0.0005 / - 0.0000

Bottom to Low Side:
Minimum is 0.0300 + 0.0000 / - 0.0005
Maximum is 0.0340 + 0.0005 / - 0.0000

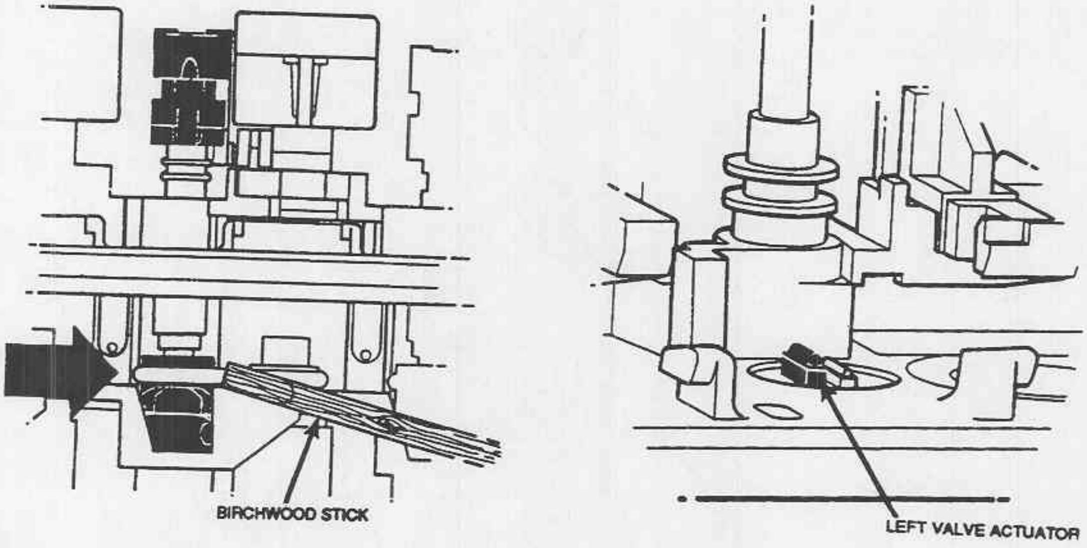
j. If the measurements are not within specification, complete the following steps.
   1. Loosen the three drive module mounting screws, using a 3/32 hex driver.
   2. Reseat the drive module.
   3. Tighten the screws to 5 in. lbf torque.
   4. Remeasure the valve actuator heights. If the measurements remain out of specification, replace the valve actuators.

k. After verifying that the right valve actuator heights are within specification, rotate the cam until the left valve actuator is at the highest position above the chassis (see Figure 7-66).

l. If the instrument is assembled, quickly pull the pump latch away from the chassis until the left actuator is at the highest position above the chassis (Figure 7-67).

m. Repeat the previous steps to measure the heights for the left valve actuator.

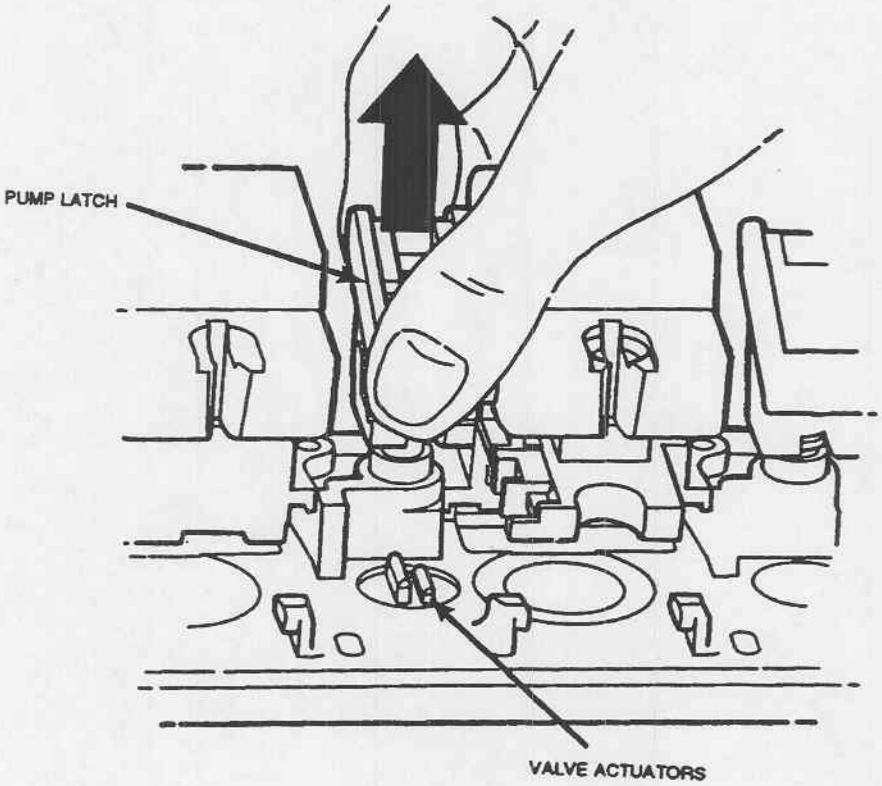
Figure 7-66. Left Valve Actuator in Highest Position


BIRCHWOOD STICK
LEFT VALVE ACTUATOR

A. ADJUSTING VALVE ACTUATOR.

B. VALVE ACTUATOR IN HIGHEST POSITION.

Figure 7-67. Positioning Left Actuator in Highest Position when Instrument is Assembled


PUMP LATCH
VALVE ACTUATORS

7.3.7 Pump Shaft

Whenever the drive module is removed and reinstalled, the valve actuator and pump latch height must be verified and, if necessary, adjusted. This is a critical step and must be performed to ensure safety, as well as proper functioning of the instrument.

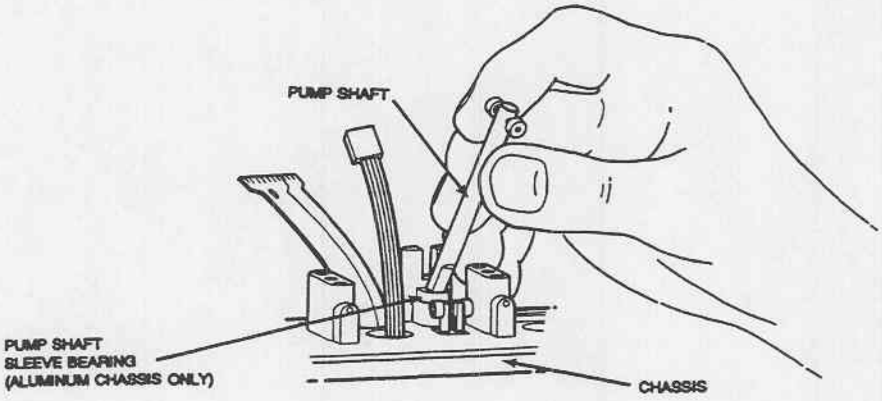
Tools required:
- #1 Phillips screwdriver
- 3/32-inch hex driver
- 5/16-inch flat blade screwdriver
- Lint-free swabs
- Magnalube-G Teflon grease
- Chassis stand
- Gauge block assembly kit
- Loctite® Assure 425 surface curing threadlocker
- 0.050-inch Allen key
- 0.050-inch hex driver

Disassembly

a. First, remove the following.
   1. Lower housing assembly (Section 7.1.1).
   2. Battery pack (Section 7.1.2).
   3. Main housing assembly (Section 7.1.3).
   4. Display module (Section 7.5.2).
   5. Power supply PCBA (Section 7.5.5).
   6. (Model 2860 only) MEA (Section 7.5.6).
   7. Pump latch assembly (Section 7.3.1).
   8. Drive module assembly (Section 7.3.4).

b. Remove the shaft.
   1. After the pump latch and drive module assemblies are removed, the pump shaft can be removed from the chassis (Figure 7-68).

Figure 7-68. ***Pump Shaft Removal***



c. Inspect for the following.
   1. Dirt or dried solution on the pump shaft bearing surfaces (Model 2860 only).
   2. Damaged pump shaft seal.
   3. Loose pump shaft bearings on the chassis (Model 2860 only).

d. Ensure the following.
   1. The pump shaft bearings rotate smoothly without excessive play.

e. Pump shaft repair and installation.
   1. Aluminum or diecast chassis with sleeve bearing (see Figure 7-69 and 7-70)
      (a) Clean the pump shaft sleeve bearings.

Figure 7-69. Machined Aluminum Chassis with Sleeve Bearings (Model 2860)

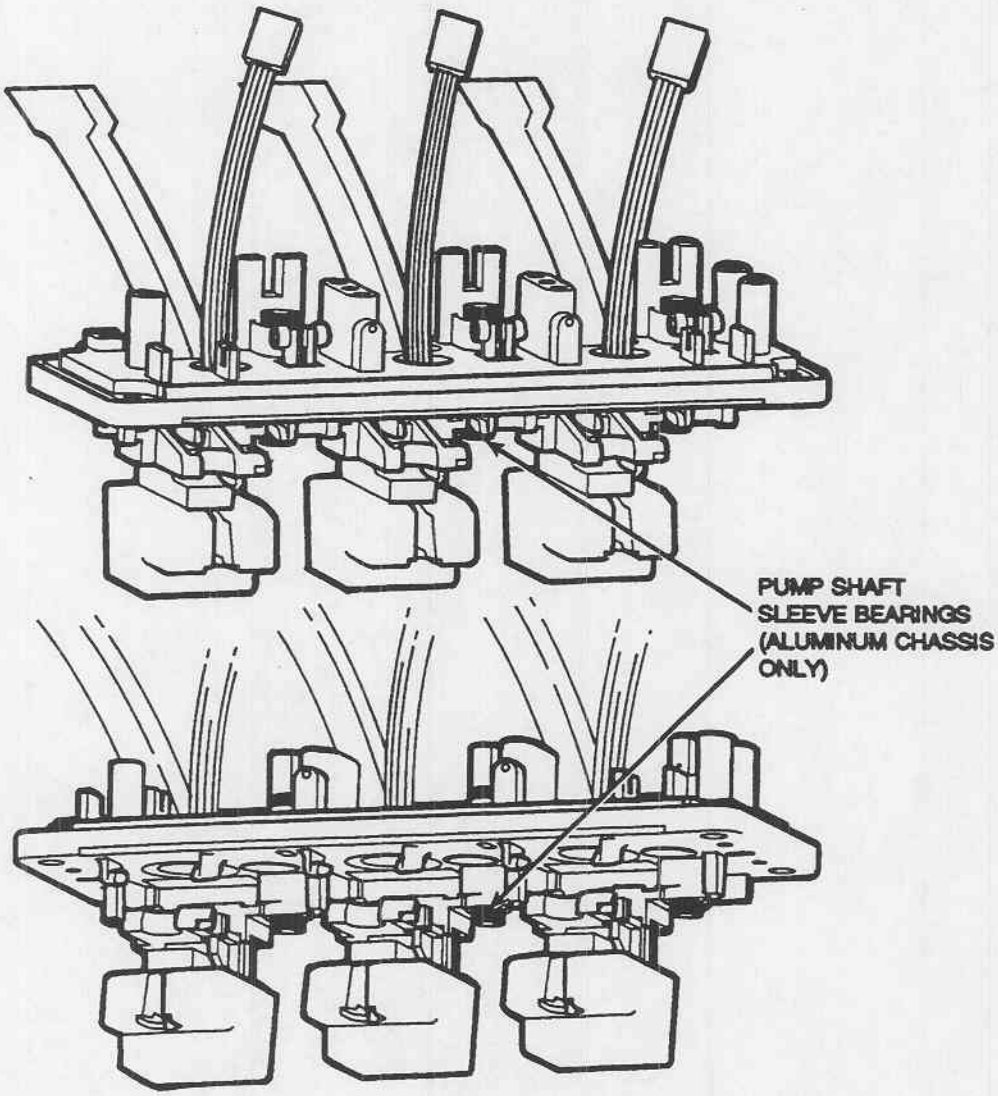
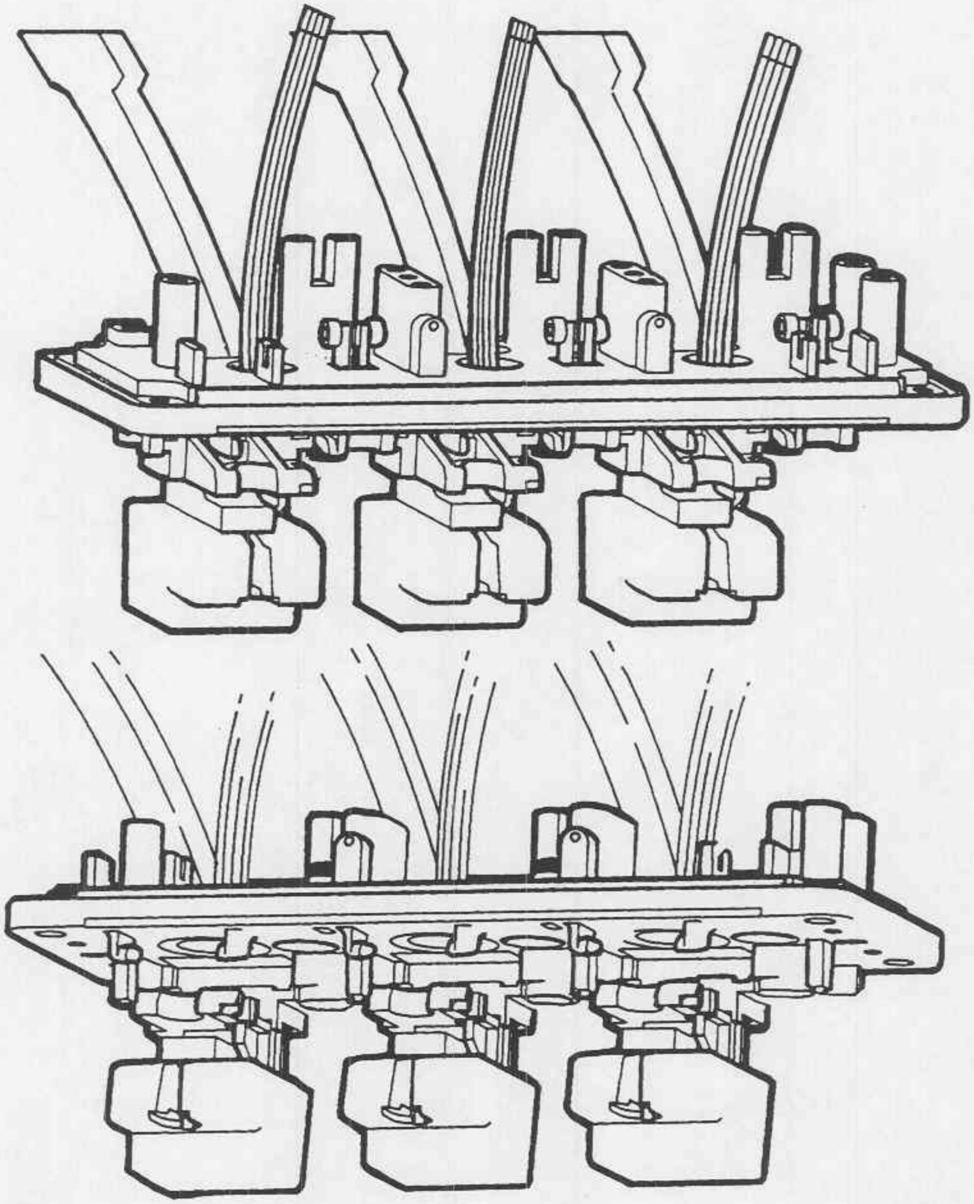


Figure 7-70. Die Cast Chassis with Sleeve Bearings (Model 2863)



(b) Using a lint-free swab, apply a very thin film of Magnalube-G Teflon grease to the shaft (Figure 7-71).

(c) Orient the shaft so that the V-slot faces the rear of the instrument (Figure 7-72). Note that the V-slot engages the locking set screws of the pump latch assembly.

(d) Insert the shaft into place in the chassis.

(e)Install the drive module (Section 7.3.5) to hold the shaft in place.

(f)Install the bearing clip to retain the pump shaft bearings (Figure 7-73).

Figure 7-71. Pump Shaft Lubrication

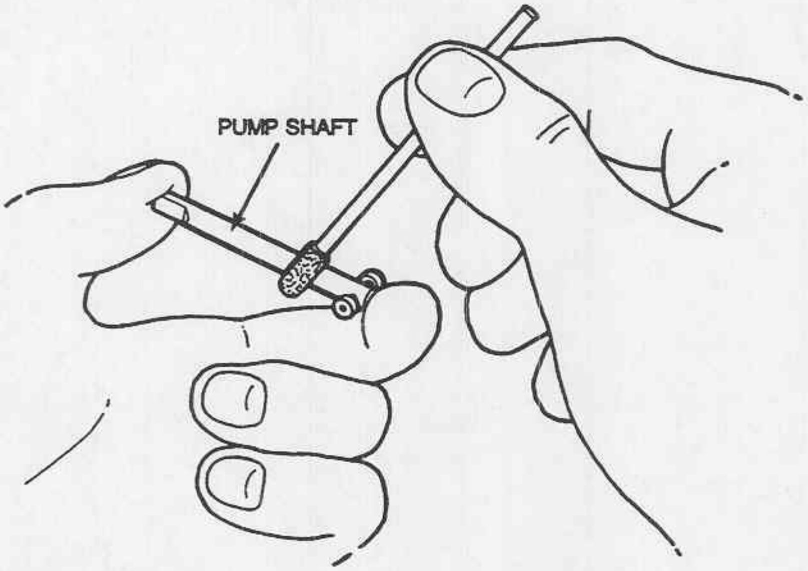
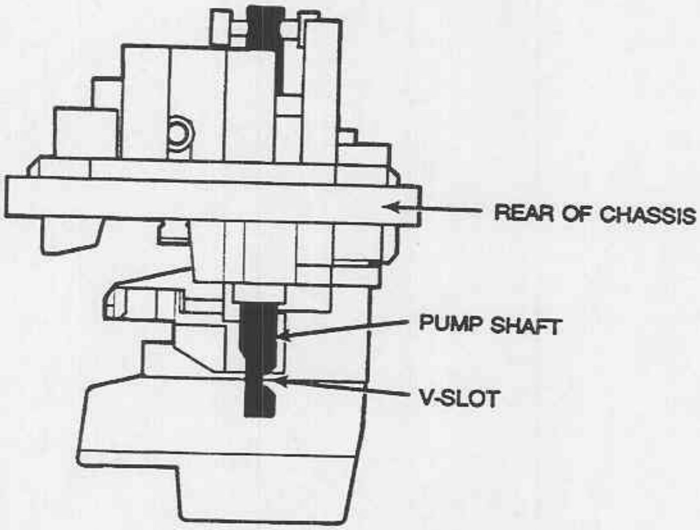


Figure 7-72. Pump Shaft V-slot Orientation


REAR OF CHASSIS
PUMP SHAFT
V-SLOT

2. Die cast chassis without sleeve bearing
   (a) The die cast chassis have an undercut in the pump shaft hole to hold a reservoir of lubricant.
   (b) Place a finger over one end of the pump shaft hole in the chassis (Figure 7-74). Fill the hole with Magnalube-G Teflon grease.

Figure 7-73. ***Bearing Clip Installation***

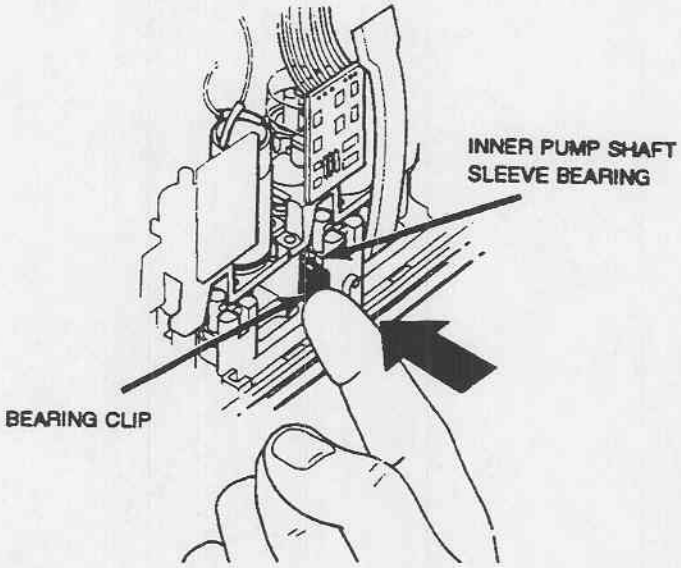
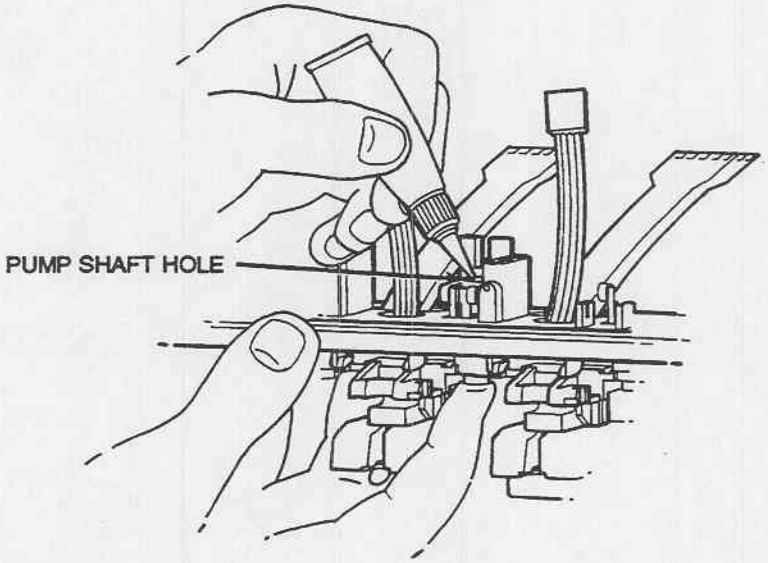


Figure 7-74. ***Pump Shaft Hole Lubrication (Diecast Chassis without Sleeve Bearing)***



(c) Orient the shaft such that the V-slot faces the rear of the instrument (Figure 7-72). Note that the V-slot engages the locking set screws of the pump latch assembly.

(d) Insert the shaft into place in the chassis.

(e) Remove all excess grease that is squeezed from the hole.

NOTE: *Excess grease can pick up dirt, contaminate the optomodule, or interfere with the pump latch operation.*

(f) Install the drive module (Section 7.3.5) to hold the shaft in place.

f. Verify the valve actuator heights.
   1. Verify that the valve actuator heights are within specifications, using the procedure described in Section 7.3.6.

g. Adjust the pump latch height.
   1. Adjust the pump latch height, using the procedure described in Section 7.3.2.

Reassembly

a. Reassembly must be completed in the following order.
   1. Pole clamp assembly (Section 7.2.1).
   2. MEA (Section 7.5.6).
   3. Power supply PCBA (Section 7.5.5).
   4. Display module (Section 7.5.2).
   5. Main housing assembly (Section 7.1.3).
   6. Battery pack (Section 7.1.2).
   7. Lower housing assembly (Section 7.1.1).

b. Recalibrate.
   1. All sensor systems must be recalibrated (Chapter 5).

c. Test.
   1. Perform run-in (Section 7.1) and all the functional checks (Chapter 3) except for the battery.

d. Restore the settings.
   1. Customized settings and the Battery History Log should be restored using FMS (refer to the FMS Directions For Use).

7.3.8 Valve Actuator Assembly Repair

> **WARNING**
>
> *Whenever the drive module is removed and reinstalled, the valve actuator and pump latch height must be verified and, if necessary, adjusted. This is a critical step and must be performed to ensure safety as well as proper functioning of the instrument.*

Tools required:

- #1 Phillips screwdriver
- 5/16-inch flat blade screwdriver
- Guide/seal socket and 1/4-inch driver
- Lint-free swabs
- Magnalube-G Teflon grease
- Chassis stand
- 3/32-inch hex driver
- Gauge block kit
- 0.050-inch hex driver
- 0.050-inch Allen key
- 5 in. lbf torque driver

- 5/64-inch ball-end hex driver or T-6 Torx driver
- Loctite® Assure 425 surface curing threadlocker

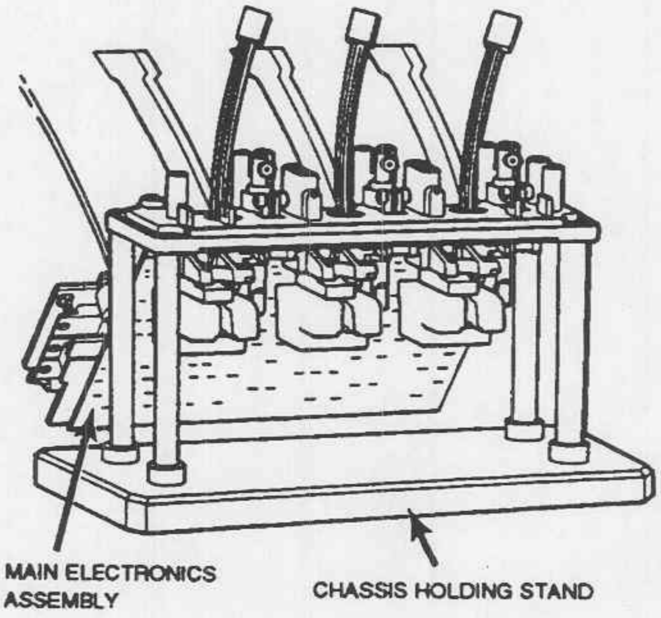
Disassembly

a. First remove:
   1. Lower housing assembly (Section 7.1.1).
   2. Battery pack (Section 7.1.2).
   3. Main housing assembly (Section 7.1.3).
   4. Display module (Section 7.5.2).
   5. Pump latch assembly (Section 7.3.1).
   6. Ground wire from chassis (Section 7.5.5).
   7. Backup battery from the locking two-pin connector (Section 7.5.3).
   8. All motor, encoder, and pressure transducer connections from MEA (Section 7.4.2).
   9. Drive module assembly (Section 7.3.5).
   10. Pole clamp assembly (Section 7.2.1).
   11. Chassis mounts (Section 7.3.9).

b. Assemble the chassis holding stand (Section 7.1).

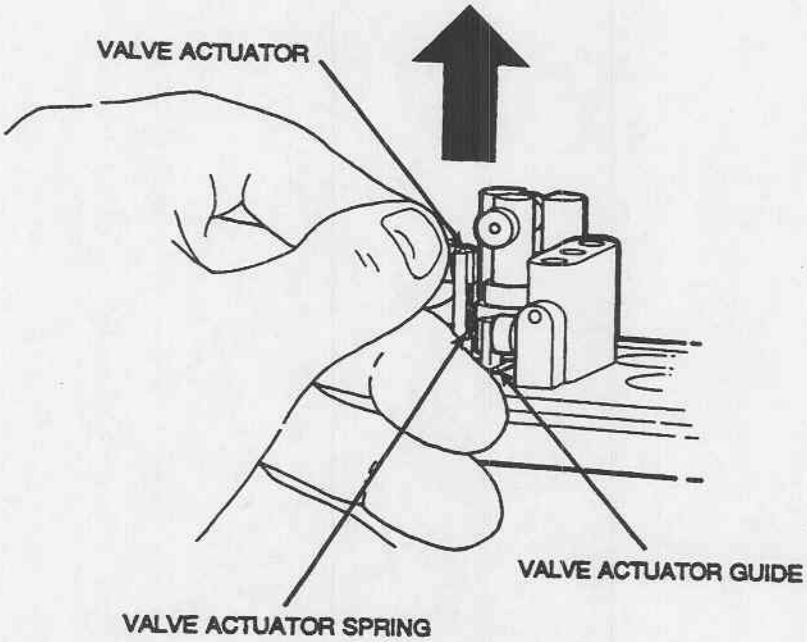
c. Remove the valve seal and guide.
   1. Carefully lift the MEA, which has the power supply PCBA attached to it, from the chassis guides.
   2. Mount the chassis on the chassis holding stand with the interior surface facing up (Figure 7-75).

Figure 7-75. Chassis Attachment to Holding Stand



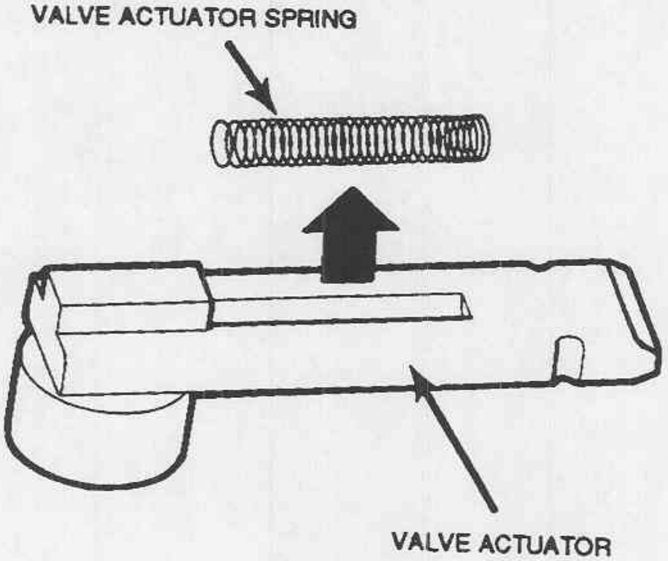
3. Position the MEA, which has the power supply PCBA attached, away from the chassis holding stand so that it allows for correct placement of the chassis (Figure 7-75).
4. Lift the valve actuators out of the guide (Figure 7-76). Some resistance may be felt as the actuators are pulled from the ring seal.

Figure 7-76. Valve Actuator Removal


VALVE ACTUATOR
VALVE ACTUATOR GUIDE
VALVE ACTUATOR SPRING

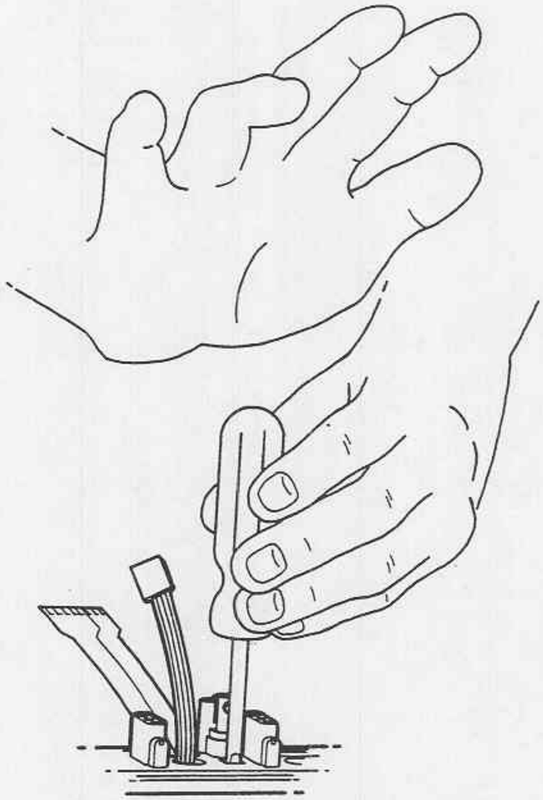
5. Remove the actuator springs located in a recess on the side of the actuator opposite the bearing (Figure 7-77).

Figure 7-77. Actuator Spring Removal


VALVE ACTUATOR SPRING
VALVE ACTUATOR

6. Place the square end of the 1/4-inch driver over the guide. Sharply tap the driver handle to remove seal and guide (Figure 7-78).

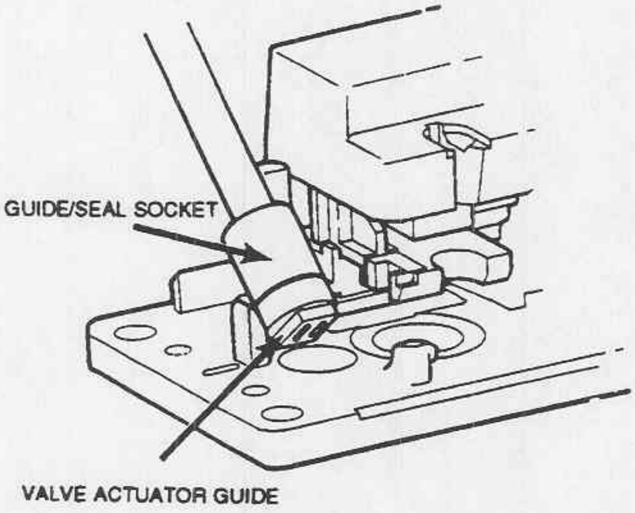
Figure 7-78. Valve Guide and Ring Seal Removal



d. Inspect for the following.
   1. Damaged or torn ring seals.
   2. Damaged valve actuators.
   3. Actuator bearings that rotate smoothly without excessive play.
   4. Dirty, bent, or damaged springs.

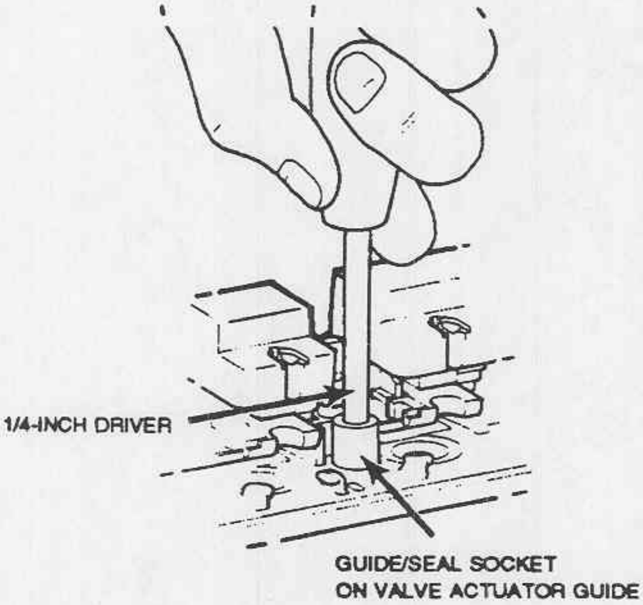
e. Install the guide and ring seal.
   1. Orient the chassis on the stand so that the inner surface is pointing down (Figure 7-75).
   2. Position the MEA, which has the power supply PCBA attached, away from the chassis stand so that it allows for correct placement of the chassis (Figure 7-75).
   3. Seat the round end of the valve guide on the guide/seal socket (Figure 7-79).
   4. Orient the slots in the valve guide perpendicular to the front panel of the instrument.

Figure 7-79. Valve Guide Orientation


GUIDE/SEAL SOCKET
VALVE ACTUATOR GUIDE

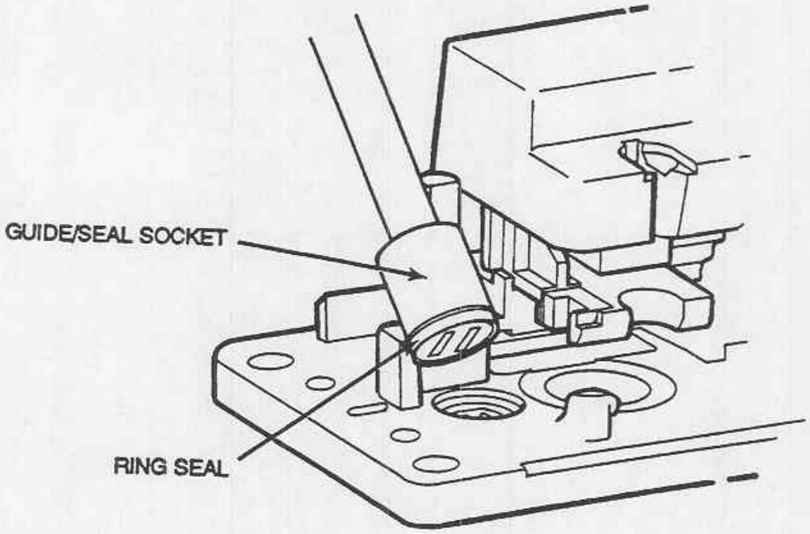
5. Firmly press the valve guide into the chassis (Figure 7-80).

Figure 7-80. Valve Guide Insertion


1/4-INCH DRIVER
GUIDE/SEAL SOCKET
ON VALVE ACTUATOR GUIDE

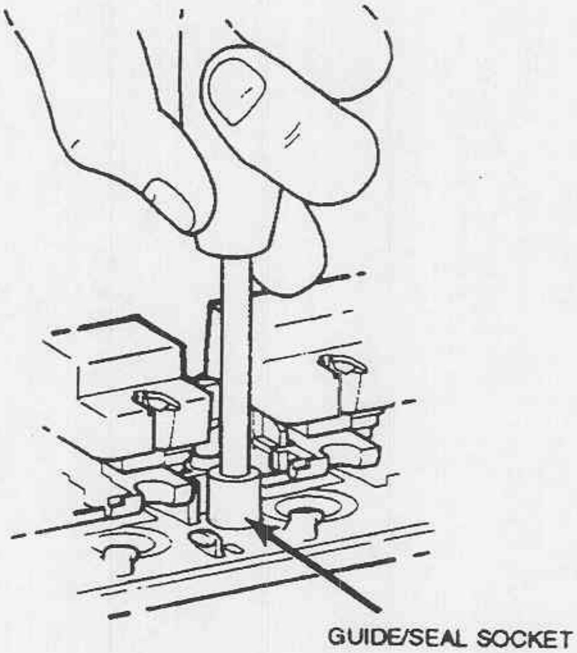
6. Seat the ring seal on the guide/seal socket with the flush side facing out (Figure 7-81).
7. Align the two socket blades with the two slots in the valve guide.

Figure 7-81. Ring Seal Orientation


GUIDE/SEAL SOCKET
RING SEAL

8. Hold the tool perpendicular to the surface of the chassis (Figure 7-82).Using firm and even pressure, push the ring seal into the chassis recess, locking the guide in place.
9. Ensure that the ring seal is flush with the chassis.

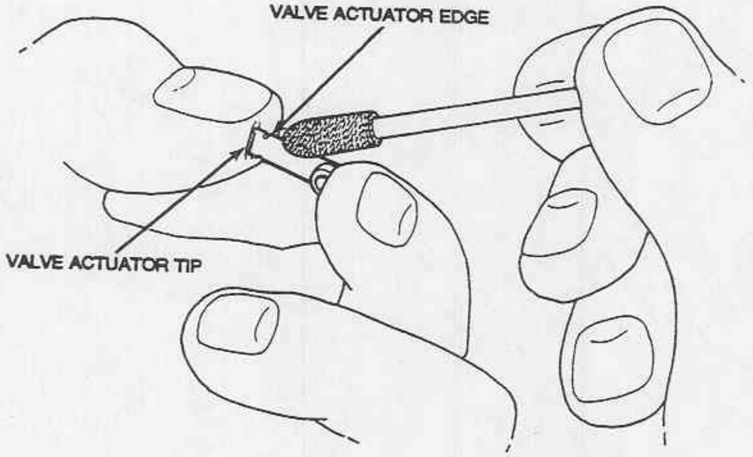
Figure 7-82. Ring Seal Insertion


GUIDE/SEAL SOCKET

f. Lubricate and install valve actuators:

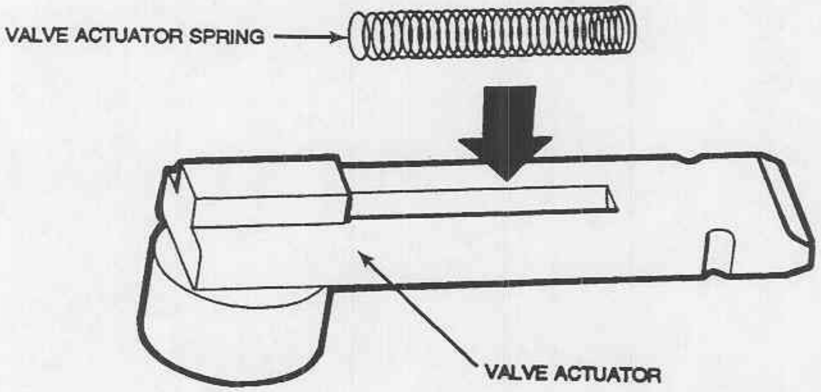
1. With a lint-free swab, apply a thin film of Magnalube-G Teflon grease to each edge of the valve actuator (Figure 7-83). Ensure that no grease gets on actuator tip.

Figure 7-83. Valve Actuator Lubrication


VALVE ACTUATOR EDGE
VALVE ACTUATOR TIP

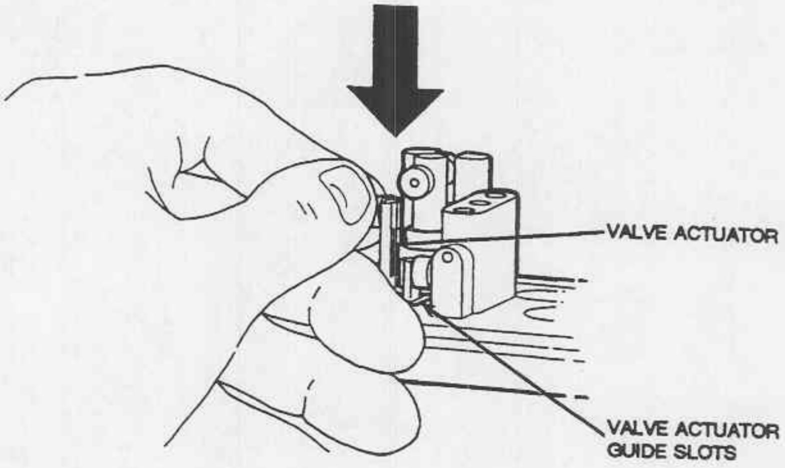
2. Insert the springs into the recess in the side of the valve actuators (Figure 7-84).

Figure 7-84. Spring Insertion into Valve Actuator Recess


VALVE ACTUATOR SPRING
VALVE ACTUATOR

3. Insert the actuators into the valve guide slots from the interior side of the chassis (Figure 7-85).
4. Orient the actuators such that the bearings are facing away from each other.

Figure 7-85. ***Valve Actuator Insertion into Guide Slots***



g. Install the drive module assembly (Section 7.3.5).

h. Verify the valve actuator heights.

   1. Verify that the valve actuator heights are within specifications, using the procedure described in Section 7.3.6.

i. Install the pump latch assembly.

   1. Install the pump latch assembly, using the procedure described in Section 7.3.1.

j. Adjust the pump latch height.

   1. Adjust the pump latch height, using the procedure described in Section 7.3.2.

k. Perform run-in.

> **CAUTION**
>
> *Use extreme care to ensure that the springs are not distorted during insertion. DO NOT apply any substance, such as grease, to hold the springs in place.*

   1. Press the actuators in completely.
   2. Ensure that the actuators move freely and spring up.
   3. Apply 13V power to the motor (positive to the red lead), and operate for 24 hours.

Reassembly

a. Reassemble in the following order.

   1. Chassis mounts (Section 7.3.8).
   2. Pole clamp assembly (Section 7.2.1).
   3. MEA (Section 7.5.6).
   4. Backup battery to locking two-pin connector (Section 7.5.3).

   5. Ground wire to chassis (Section 7.5.5)
   6. Display module (Section 7.5.2).
   7. Main housing assembly (Section 7.1.3).
   8. Battery pack (Section 7.1.2)
   9. Lower housing assembly (Section 7.1.1).

b. Recalibrate.
   1. All sensor systems must be recalibrated (Chapter 5).

c. Test.
   1. Perform run-in (Section 7.1) and all the functional checks (Chapter 3) except for the battery.
   2. Use negative head heights when performing the volume accuracy test to ensure proper operation of the valve actuator assembly.

d. Restore the settings.
   1. Customized settings and the Battery History Log should be restored using FMS (refer to the FMS Directions For Use).

7.3.9 Repair or Replacement of Chassis Mounts

Tools required:

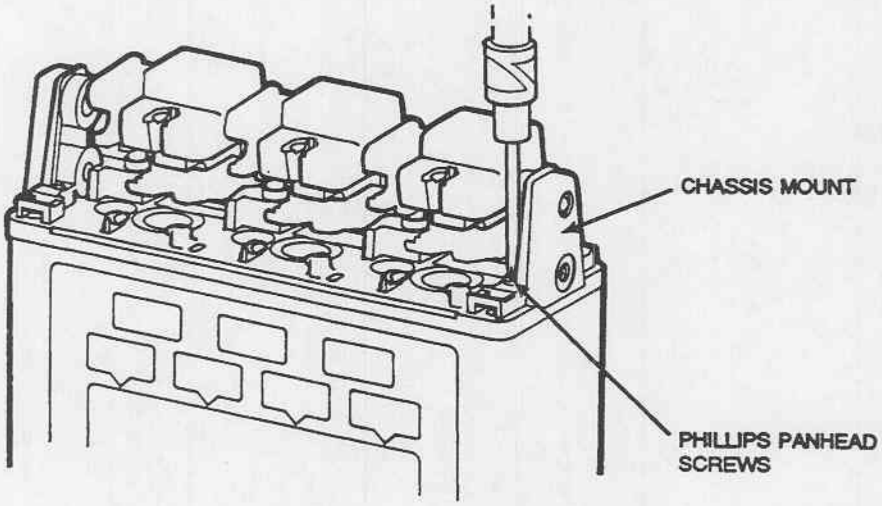
- #1 Phillips screwdriver
- Ball plunger adjustment tool

Disassembly

a. First, remove the following.
   1. Lower housing assembly (Section 7.1.1).
   2. Pole clamp assembly (Section 7.2.1).

b. Remove the chassis mounts.
   1. Remove the two Phillips panhead screws on each mount (Figure 7-86).

Figure 7-86. ***Chassis Mount Removal***



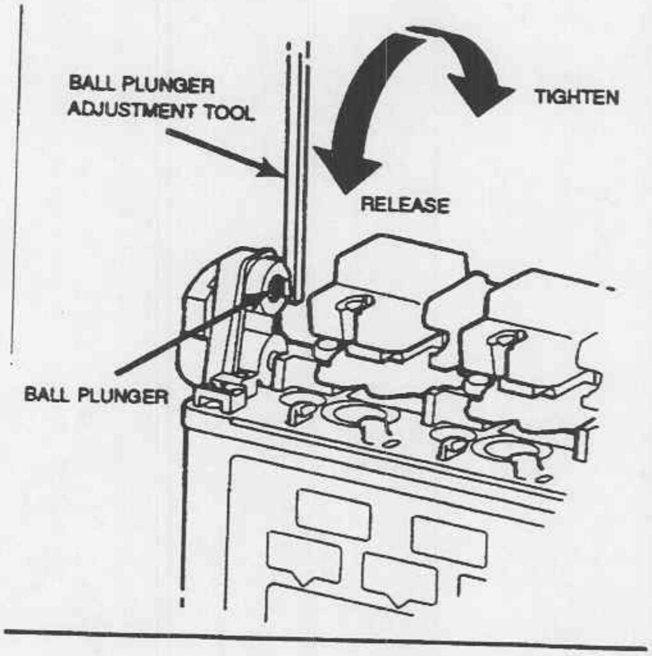
Reassembly

a. Reinstall the chassis mounts.
   1. Chassis mounts are installed in the reverse order of removal.

b. Reassemble in the following order.
   1. Pole clamp assembly (Section 7.2.1).
   2. Lower housing assembly (Section 7.1.1).

c. Ball plunger adjustment (Figure 7-87).
   1. Using the ball plunger adjustment tool, turn the ball plunger clockwise until contact is made with the pole clamp assembly.
   2. Adjust the ball plunger by turning counterclockwise 1/4 turn (Figure 7-87).

Figure 7-87. Ball Plunger Adjustment

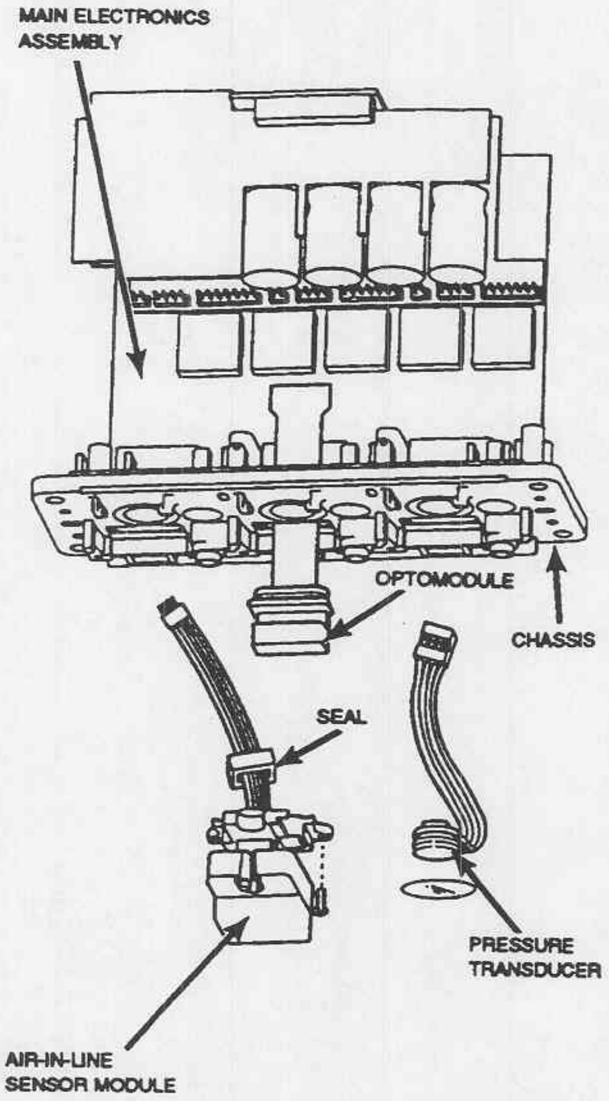


7.4 Sensors

The sensors are depicted in Figure 7-88.

NOTE: *Two different types of chassis were produced. Early versions were machined from aluminum, and the later versions are die cast. The machined aluminum versions are silver colored and can be identified by the white plastic pump shaft sleeve bearings (see Figure 7-28). Die cast chassis use a shorter air-in-line sensor module seal.*

Figure 7-88. Exploded View of Sensor Systems


MAIN ELECTRONICS
ASSEMBLY
OPTOMODULE
CHASSIS
SEAL
PRESSURE
TRANSDUCER
AIR-IN-LINE
SENSOR MODULE

NOTE: *The Model 2863 Air-in-line connector will appear differently.*

7.4.1 Air-in-line Sensor Replacement

Tools required:

- 3/32-inch hex driver
- Small flat blade screwdriver
- Tweezers
- 5/64-inch ball-end hex driver or T-6 Torx driver
- 3 in. lbf torque driver
- (For Model 2860 only) X-ACTO knife

- (For Model 2860 only) 0.5-inch length of 0.25-inch-diameter heat-shrink tubing (must be UL 224 or CSA 198 approved, e.g., Alpha FIT-221).

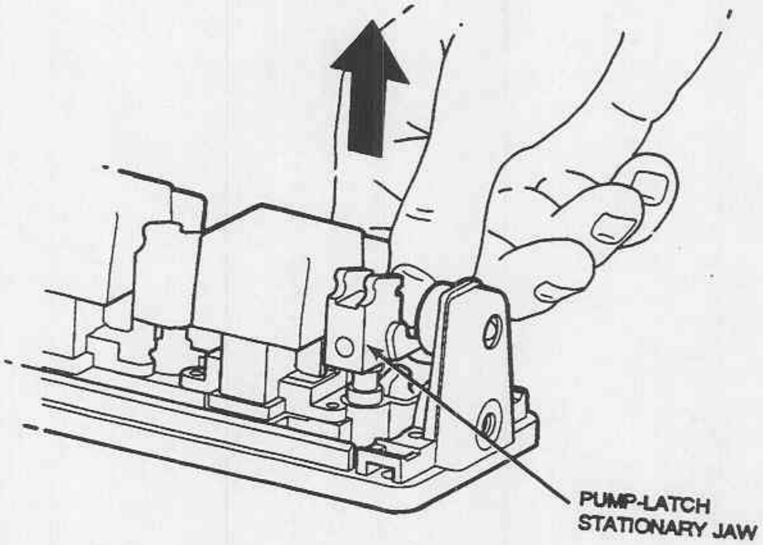
Disassembly

a. First, remove the following.
   1. Lower housing assembly (Section 7.1.1).
   2. Pump latch movable jaw (Section 7.3.3).
   3. Battery pack (Section 7.1.2).
   4. Main housing assembly (Section 7.1.3).

b. Loosen the air-in-line sensor.

c. Lift the pump latch stationary jaw so that it is at the top of the stroke (i.e., stationary jaw is in the farthest position from the chassis). (See Figure 7-89.)

Figure 7-89. ***Pump Latch Stationary Jaw in Farthest Position above Chassis***



d. Loosen the air-in-line sensor mounting screws with a 7/64-inch ball-end hex driver or T-6 Torx driver (Figure 7-90).

e. Remove the sensor.
   1. (For Model 2860 only) Remove the heat-shrink tubing or tape that secures the sensor connector to the back of the MEA (Figure 7-91).
   2. Disconnect the sensor from the MEA, and slide the flex through the slot in the chassis (Figure 7-92).

Figure 7-90. Air-in-line Sensor Mounting Screws

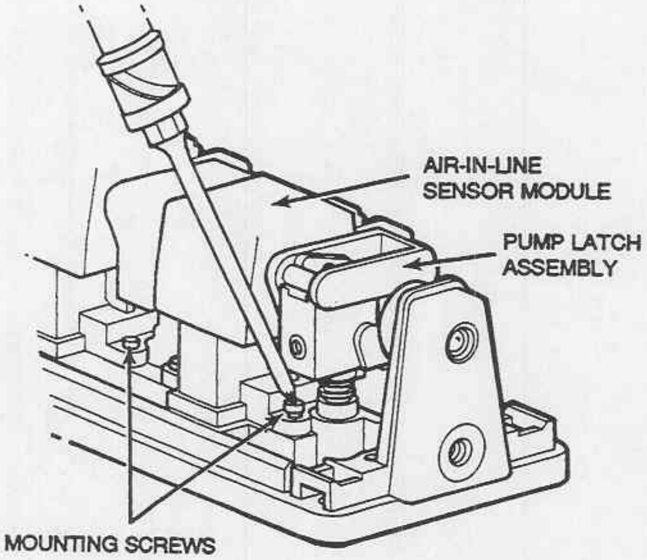
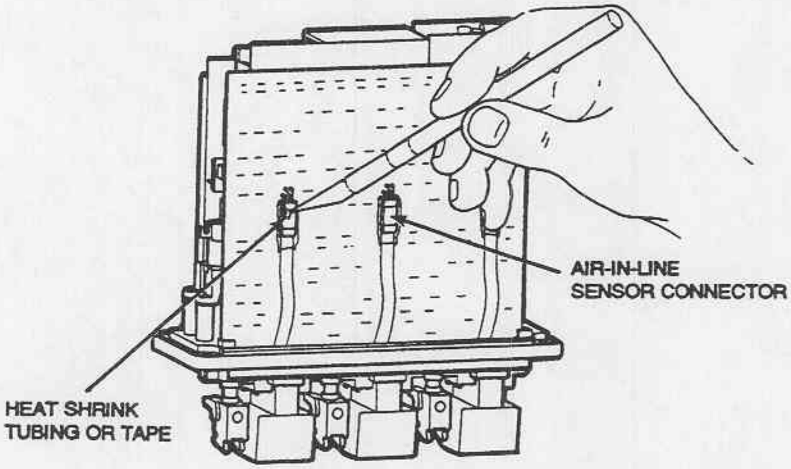
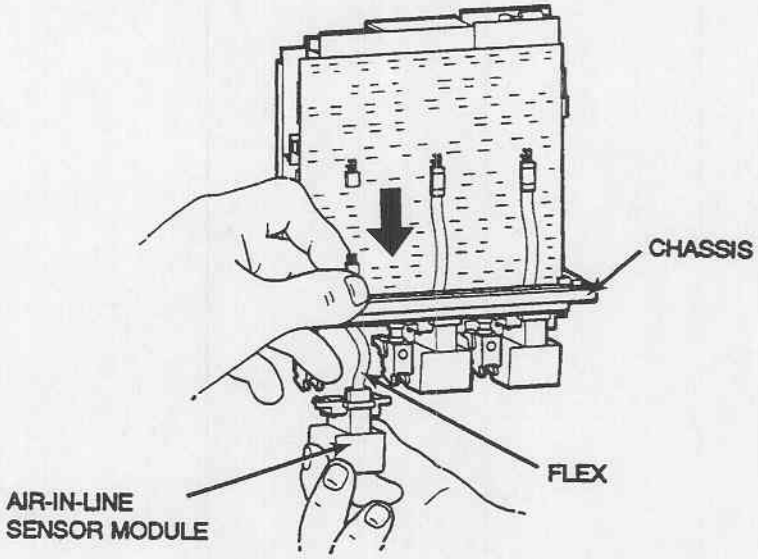

AIR-IN-LINE SENSOR MODULE
PUMP LATCH ASSEMBLY
MOUNTING SCREWS

Figure 7-91. Heat Shrink Tubing or Tape Removal


AIR-IN-LINE SENSOR CONNECTOR
HEAT SHRINK TUBING OR TAPE

NOTE: *The Model 2863 connectors and board will appear differently.*

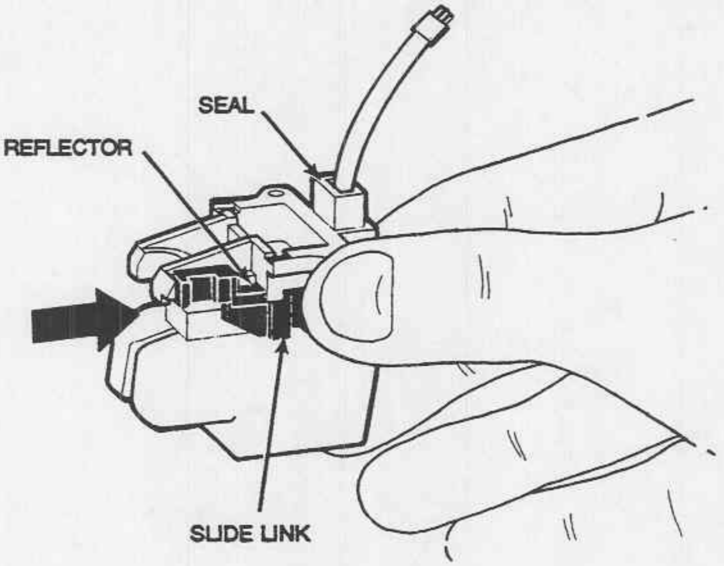
Figure 7-92. Air-in-line Sensor Module Removal


CHASSIS
FLEX
AIR-IN-LINE
SENSOR MODULE

NOTE: *The Model 2863 connectors and board will appear differently.*

3. Remove and save the slide link, being careful not to touch the reflector Figure 7-93).

Figure 7-93. Slide Link Reflector


SEAL
REFLECTOR
SLIDE LINK

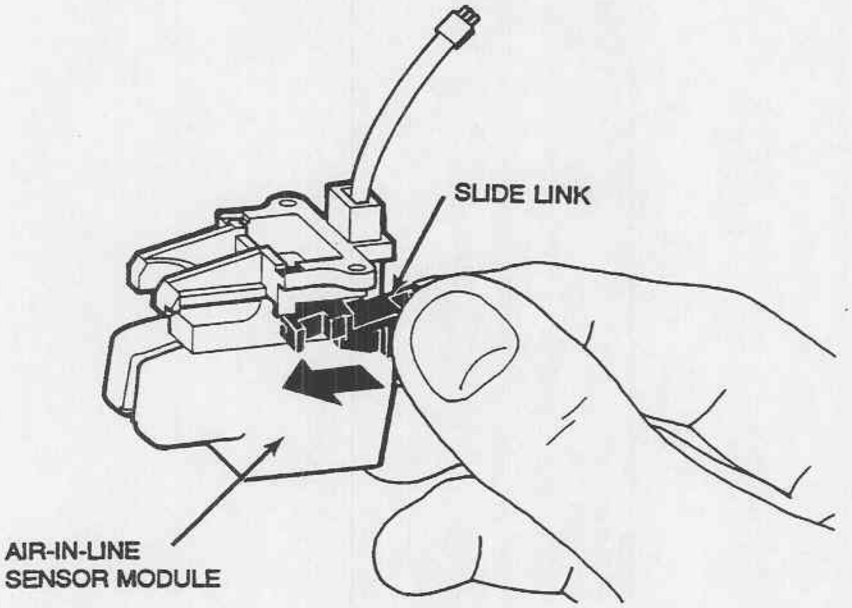
NOTE: *The Model 2863 connector will appear differently.*

f. Inspect for the following.
    1. Cracked or damaged sensor housing.
    2. Dirty sensor tubing slot; clean, if necessary.
    3. Damaged seal.
    4. Damaged flex or connector.
    5. Damaged slide link reflector.

Reassembly

a. Reassemble in the following order.
    1. Install the slide link on the sensor module guide (Figure 7-94).

Figure 7-94. ***Slide Link Installation***



NOTE: *The Model 2863 connector will appear differently.*

2. Ensure that the proper seal is attached to the sensor module (Figure 7-95). Refer to the illustrated parts list in Appendix E.
3. Feed the flex through the slot in the chassis (Figure 7-96).
4. Install screws and tighten to 3 in. lbf torque.
5. (For Model 2860 only) Slide a 0.50-inch-long piece of 0.25-inch-diameter UL-approved heat-shrink tubing over the sensor flex (Figure 7-97).

Figure 7-95. *Air-in-line Sensor Module Seal*

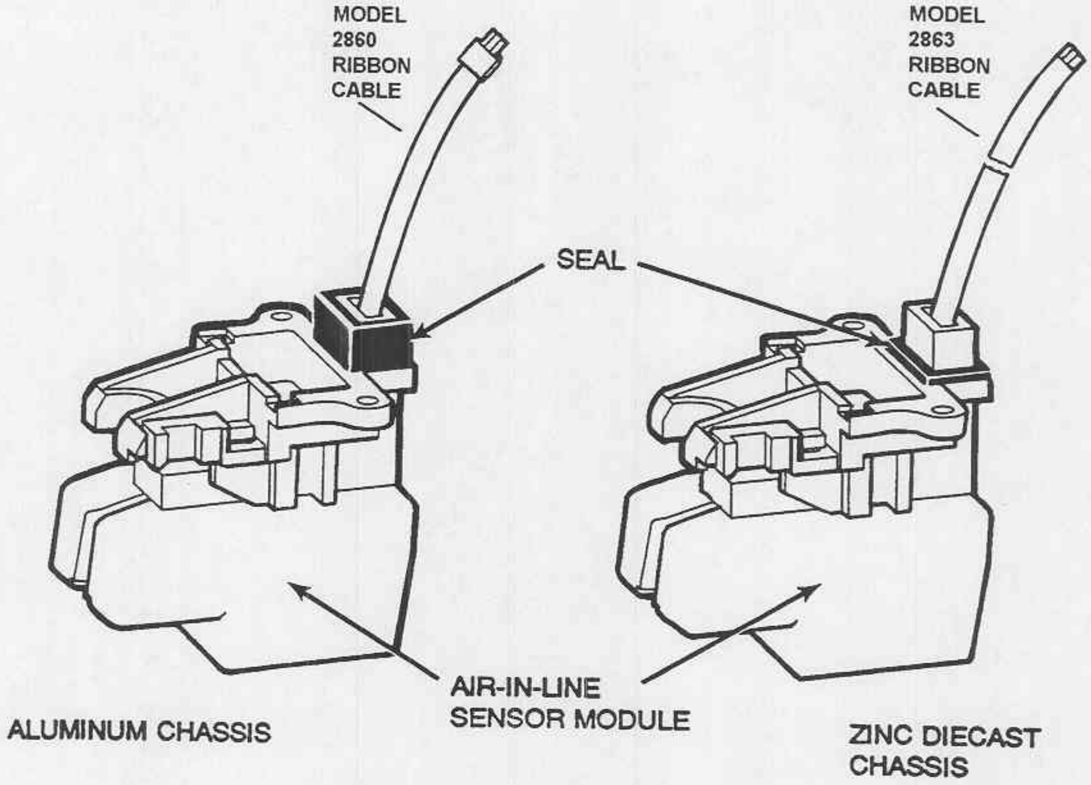
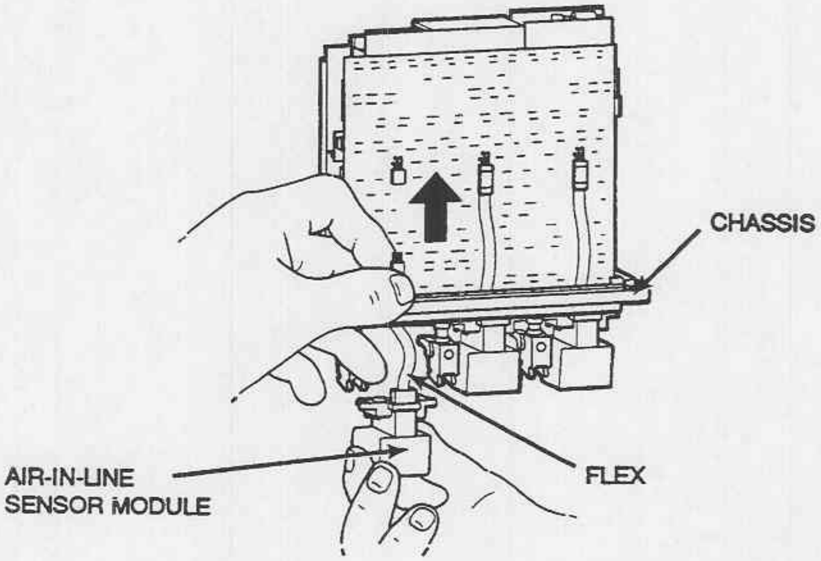
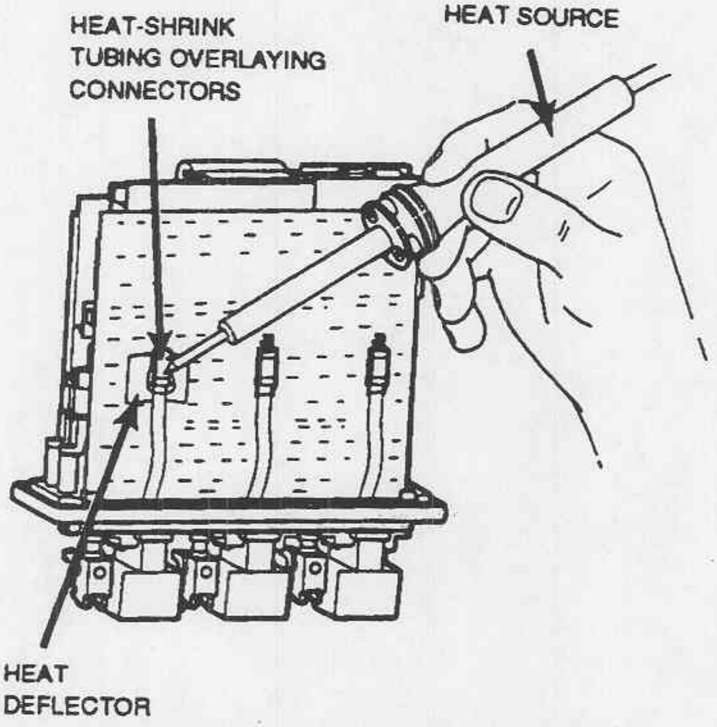

MODEL 2860 RIBBON CABLE
MODEL 2863 RIBBON CABLE
SEAL
AIR-IN-LINE SENSOR MODULE
ALUMINUM CHASSIS
ZINC DIECAST CHASSIS

Figure 7-96. *Air-in-line Sensor Module Reassembly*


CHASSIS
FLEX
AIR-IN-LINE SENSOR MODULE

NOTE: *The Model 2863 connectors and board will appear differently.*

Figure 7-97. Heat-shrink Tubing Application



NOTE: *The Model 2863 connectors and board will appear differently.*

6. (For Model 2860 only) Mate the heat-shrink tubing over both connectors.
7. Ensure complete coverage. Use a thin heat deflector under the connector to prevent thermal damage. Apply heat.
8. (For Model 2863 only) Connect the ultrasensor tail flexes to the main board assembly. Fold the ultrasensor tail flexes so that the outside loop is down and against the circuit board. Apply a 1-1/2" ± 1/4" of 1/4" Kapton tape on the folded area.
9. The remaining components are to be reassembled in the following order.
   - Main housing assembly (Section 7.1.3).
   - Battery pack (Section 7.1.2).
   - Pump latch movable jaw (Section 7.3.3).
   - Lower housing assembly (Section 7.1.1).

b. Recalibrate.

1. All sensor systems must be recalibrated (Chapter 5).

c. Test.

1. Perform run-in (Section 7.1) and all the functional checks (Chapter 3) except for the battery.

d. Restore the settings.

1. Customized settings and the Battery History Log should be restored using FMS (refer to the FMS Directions For Use).

7.4.2 Optomodule Repair or Replacement

Tools required:

- #1 Phillips screwdriver
- 3/32-inch hex driver
- Small flat blade screwdriver
- Tweezers
- 5/64-inch ball-end driver or T-6 Torx driver
- 3-in. lbf torque driver
- (For Model 2860 only) X-ACTO knife
- (For Model 2860 only) 0.50-inch length of 0.25-inch-diameter heat-shrink tubing (must be UL 224 and CSA 198 approved, e.g., Alpha FIT-221)
- Needle nose pliers

Disassembly

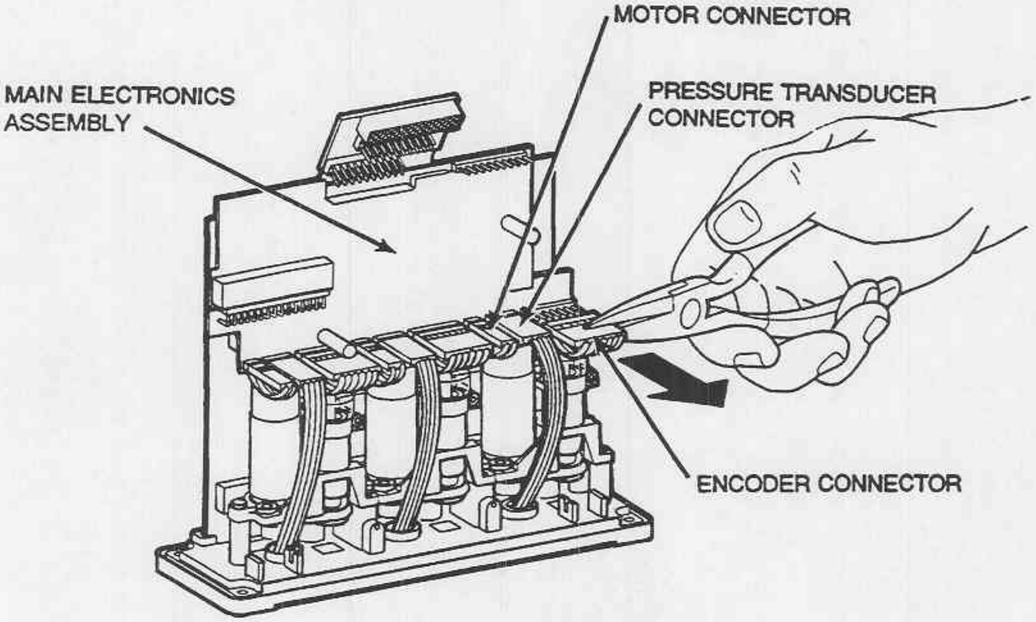
a. First, remove the following.

   1. Lower housing assembly (Section 7.1.1).
   2. Pump latch movable jaw (Section 7.3.3).
   3. Battery pack (Section 7.1.2).
   4. Main housing assembly (Section 7.1.3).
   5. Air-in-line sensor (Section 7.4.1).
   6. Display module (Section 7.5.2).
   7. Power supply PCBA (Section 7.5.5).

b. Disconnect the optomodule flex.

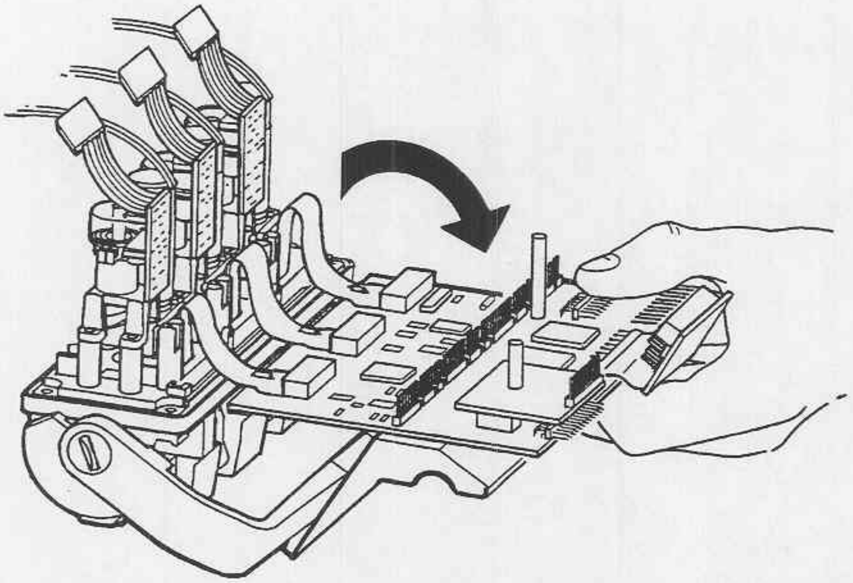
   1. Using needle-nose pliers, disconnect the motor from the MEA, pressure transducer, and encoder for all three channels (Figure 7-98). DO NOT pull on the wires. Note the orientation of the connectors.

Figure 7-98. Motor, Pressure Transducer, and Encoder Disconnection



2. Carefully lay the MEA down on a table. Unlock the flex connector and remove the flex (Figure 7-99).

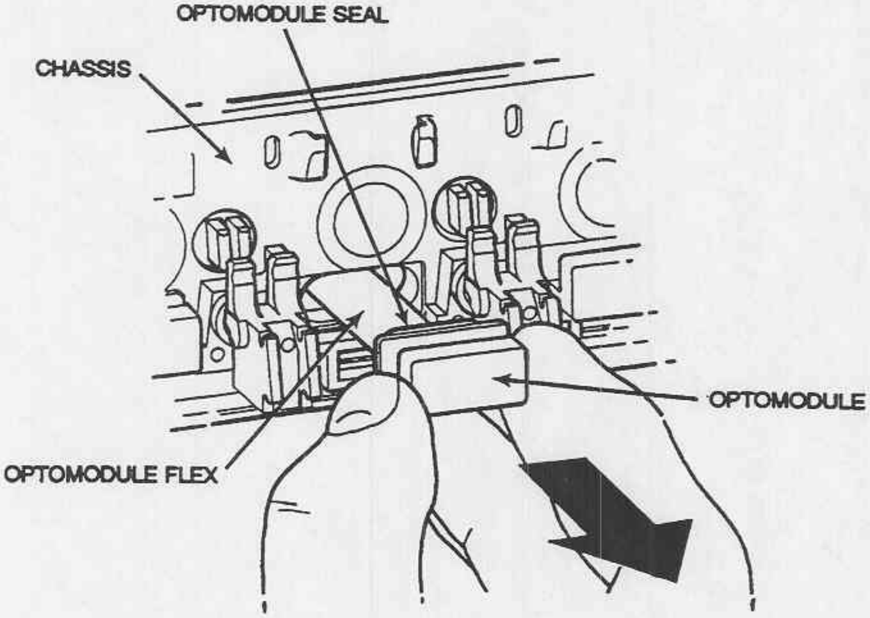
Figure 7-99. **Optomodule Flex Disconnection**



c. Remove the optomodule.

1. Remove the optomodule from the chassis, using care to guide the flex cable through the slot (Figure 7-100).

Figure 7-100. **Optomodule Removal**

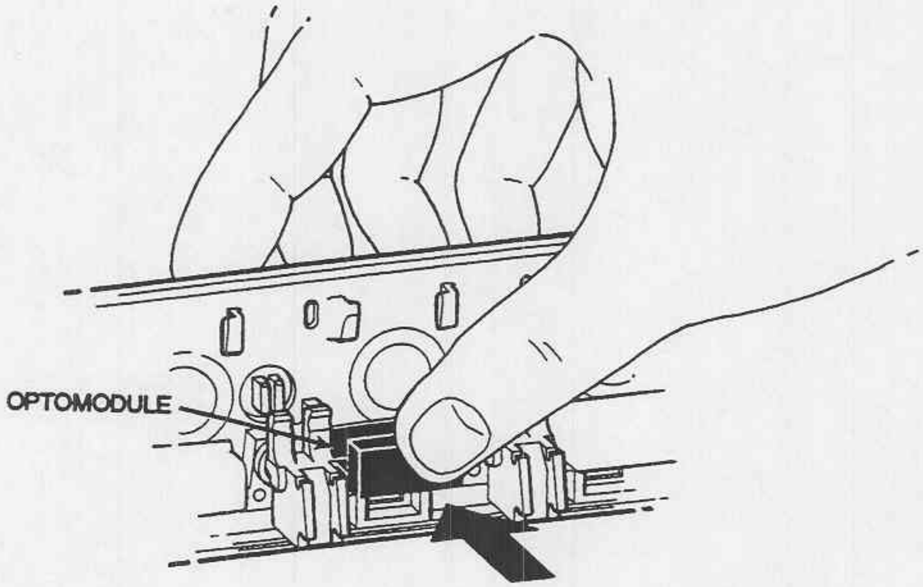

OPTOMODULE SEAL
CHASSIS
OPTOMODULE
OPTOMODULE FLEX

d. Inspect for the following.
   1. Damaged optomodule seals.
   2. Dirty or damaged sensor lenses.
   3. Damaged flex.
   4. Properly aligned and spaced flex contacts.
   5. Slide link reflector damage.

Reassembly

a. Reassemble in the following order.
   1. Seat the optomodule into the chassis so that the base is flush with the chassis surface (Figure 7-101).
   2. Insert the flex into the connector and lock.

Figure 7-101. Optomodule Installation



   3. Reassemble the remaining components in the following order.
      (a) Air-in-line sensor module (Section 7.4.1).
      (b) Power supply PCBA (Section 7.5.5).
      (c) Display module (Section 7.5.2).
      (d) Main housing assembly (Section 7.1.3).
      (e) Battery pack (Section 7.1.2).
      (f) Pump latch movable jaw (Section 7.3.2).
      (g) Lower housing assembly (Section 7.1.1).

b. Recalibrate.

  1. All sensor systems must be recalibrated (Chapter 5).

c. Test.

  1. Perform run-in (Section 7.1) and all the functional checks (Chapter 3) except for the battery.

d. Restore the settings.

  1. Customized settings and the Battery History Log should be restored using FMS (refer to the FMS Directions For Use).

7.4.3 Pressure Transducer Replacement

> **WARNING**
>
> *Whenever the drive module is removed and reinstalled, the valve actuator and pump latch height must be verified and, if necessary, adjusted. This is a critical step and must be performed to ensure safety, as well as proper functioning of the instrument.*

Tools required:

- #1 Phillips screwdriver
- 5/16-inch flat blade screwdriver
- 3/32-inch hex driver
- Magnalube-G Teflon grease
- Chassis stand
- Gauge block assembly kit
- Loctite® Assure 425 surface curing threadlocker
- Nonmetallic scraper
- Lint-free swabs
- Isopropyl alcohol
- Loctite® primer "N"
- Loctite® 518 gasket eliminator

Disassembly

a. First, remove the following.

  1. Lower housing assembly (Section 7.1.1).
  2. Battery pack (Section 7.1.2)
  3. Main housing assembly (Section 7.1.3)
  4. Display module (Section 7.5.2)
  5. Pump latch movable jaw (Section 7.3.3).
  6. Air-in-line sensor (Section 7.4.1).
  7. Ground wire from chassis (Section 7.5.5).
  8. Backup battery from the locking two-pin connector (Section 7.5.3).
  9. All motor, encoder, and pressure transducer connections from MEA (Section 7.4.2).
  10. Drive module assembly (Section 7.3.5).

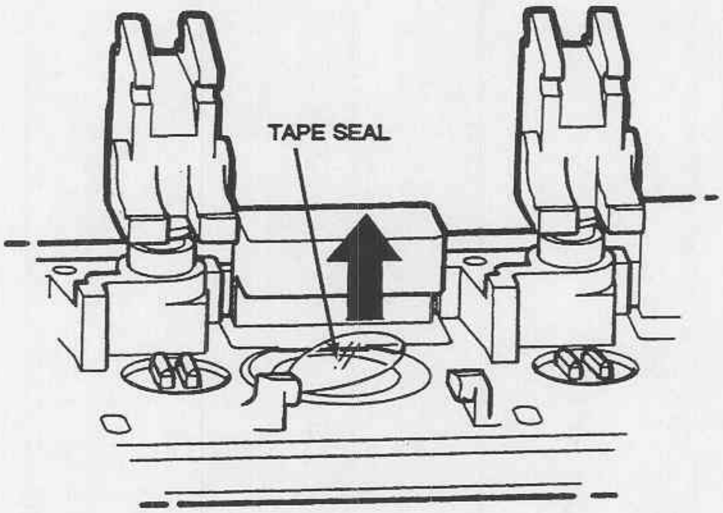
11. Pole clamp assembly (Section 7.2.1).
12. Chassis mounts (Section 7.3.9).

b. Assemble the chassis holding stand (Section 7.1).

c. Remove the pressure transducer.

1. Carefully lift the MEA, which has the power supply PCBA attached to it, from the chassis guides.
2. Mount the chassis on the chassis holding stand with the interior surface facing up (Figure 7-75).
3. Position the MEA, which has the power supply PCBA attached away from the chassis holding stand so that it allows for correct placement of the chassis (Figure 7-75).
4. Remove the tape seal covering the pressure transducer (Figure 7-102).

Figure 7-102. Tape Seal Removal



5. With a cotton swab, apply isopropyl alcohol to both sides of the seam between the chassis and transducer. Let the alcohol soak into the seam for about 30 seconds (Figure 7-103).
6. Using a blunt instrument, press the transducer from the inside of the chassis (Figure 7-104).

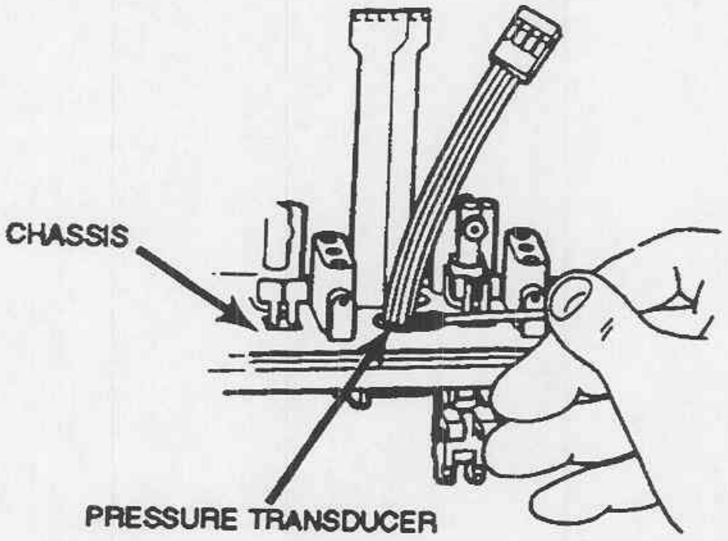
   NOTE: *A pressure transducer must not be reused.*

Reassembly

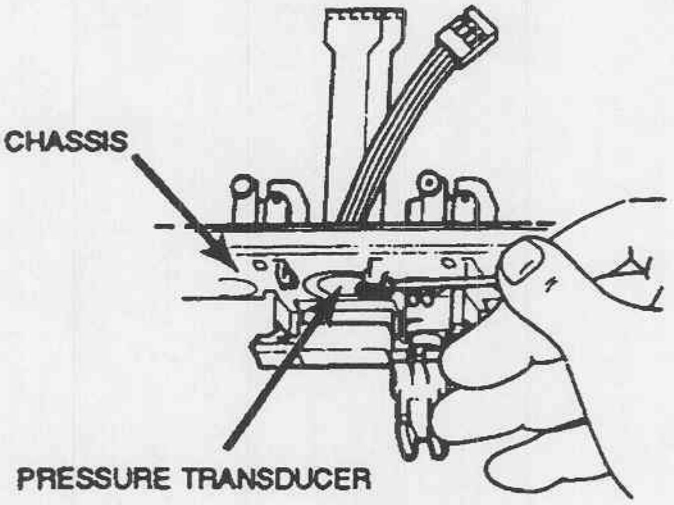
a. Prepare the surface.

1. Reverse the position of the chassis by placing the chassis in the chassis holding stand with the motors facing down (Figure 7-63).
2. Apply isopropyl alcohol to any residue remaining in the transducer hole.

Figure 7-103. Isopropyl Alcohol Application to Pressure Transducer


CHASSIS
PRESSURE TRANSDUCER

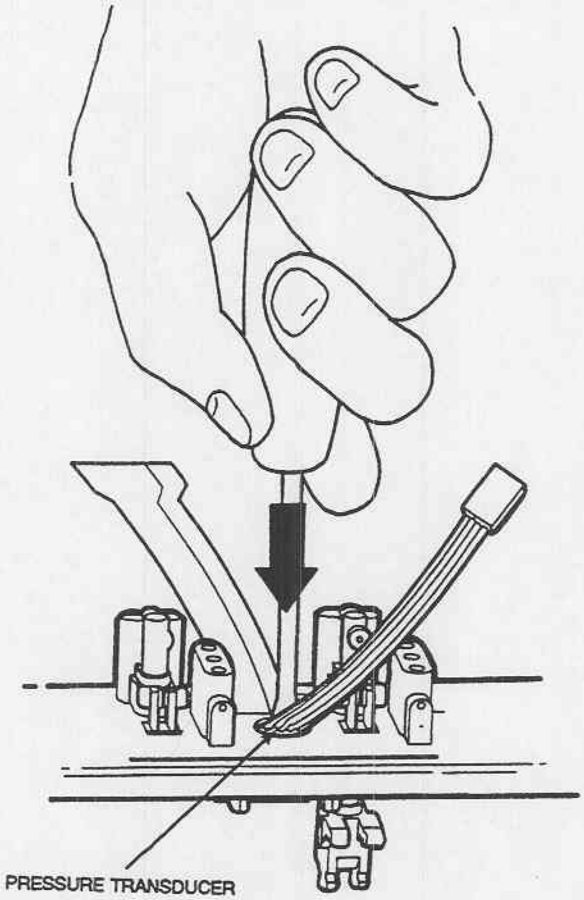
A. APPLICATION ABOVE PRESSURE TRANSDUCER.


CHASSIS
PRESSURE TRANSDUCER

B. APPLICATION BELOW PRESSURE TRANSDUCER.

NOTE: *The Model 2863 connectors will appear differently.*

Figure 7-104. Pressure Transducer Removal



NOTE: *The Model 2863 connector will appear differently.*

3. Using a nonmetallic instrument that will not scratch the metal surface, remove any remaining residue.
4. Using a lint-free swab, prime the transducer hole surface with Loctite primer "N". Wait 5 minutes and apply a second coat.
5. Apply one coat of Loctite primer "N" to the pressure transducer sides.
6. Let both surfaces dry for 5 minutes.

   NOTE: *Do not substitute other adhesives or primers.*

b. Install a new transducer.

1. Apply a small bead of Loctite 518 on the inner wall near the shoulder (Figure 7-105).
2. With the red stripe on the cable oriented to the left (when you are facing toward the front of the chassis, motors down, and transducer cable toward the front) insert the new transducer in the hole (Figure 7-106).

> **CAUTION**
>
> *DO NOT press or dent the top surface of the transducer.*

Figure 7-105. Pressure Transducer Adhesive Application

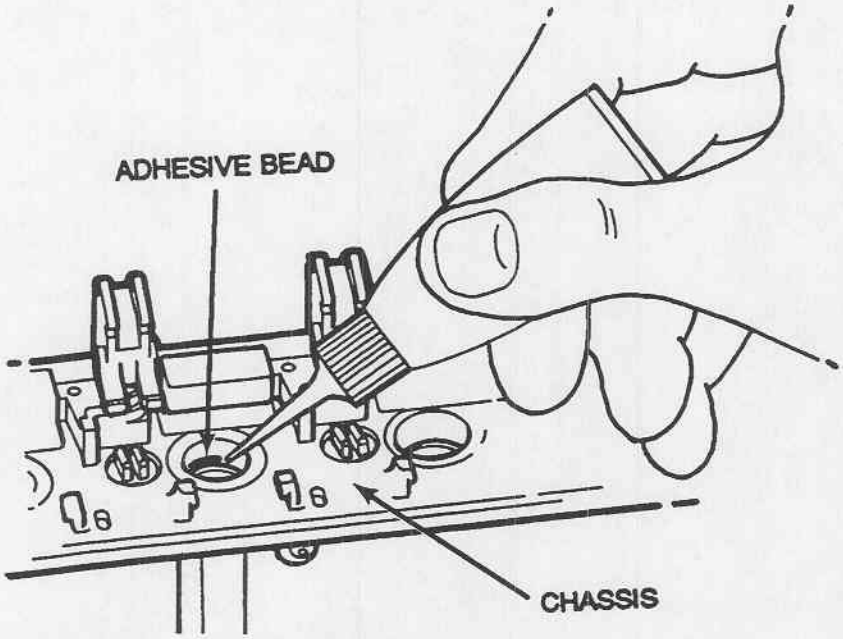
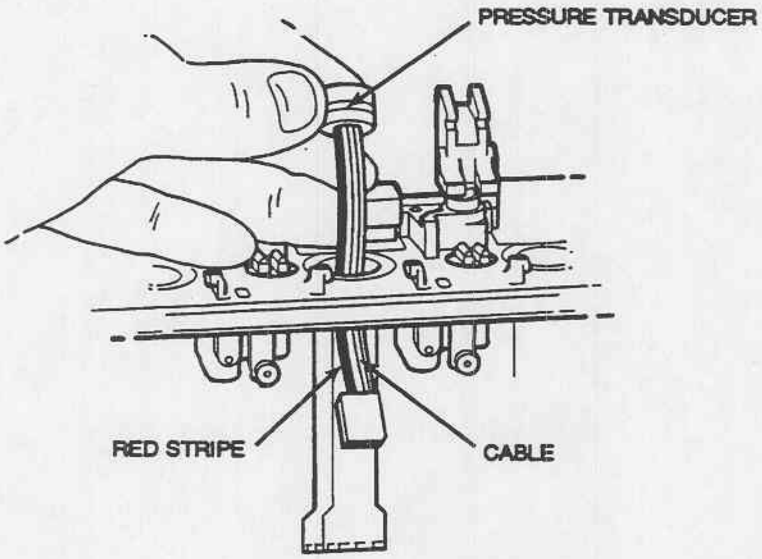

ADHESIVE BEAD
CHASSIS

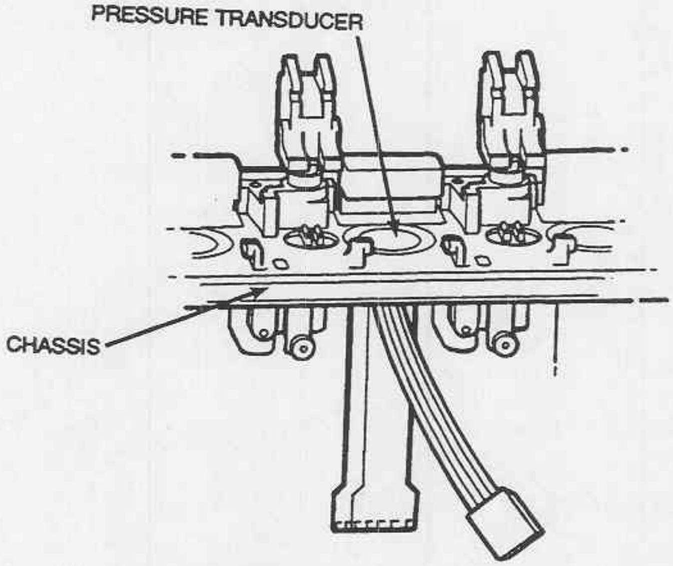
Figure 7-106. Chassis Orientation for Pressure Transducer Insertion


PRESSURE TRANSDUCER
RED STRIPE
CABLE

NOTE: *The Model 2863 connector will appear differently.*

3. Gently press along the edges of the transducer until the top surface is flush with the chassis (Figure 7-107).
4. Cure for 15 minutes.

Figure 7-107. Pressure Transducer Insertion

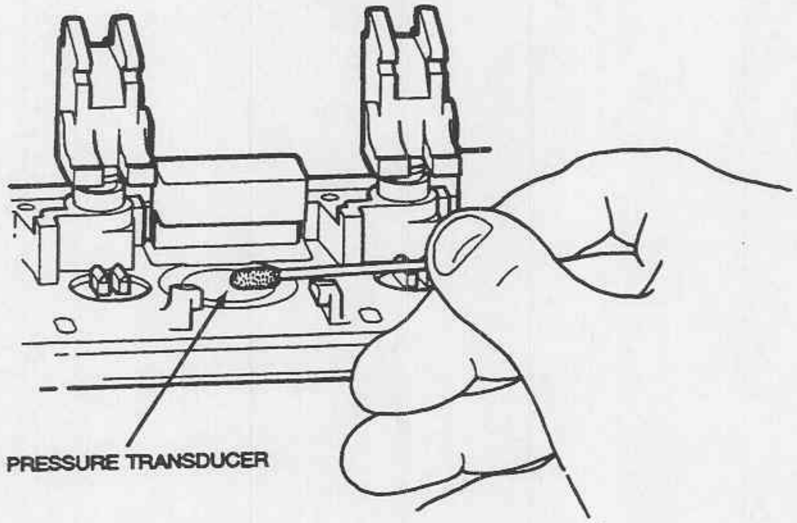

PRESSURE TRANSDUCER
CHASSIS

NOTE: *The Model 2863 connector will appear differently.*

c. Apply tape seal.

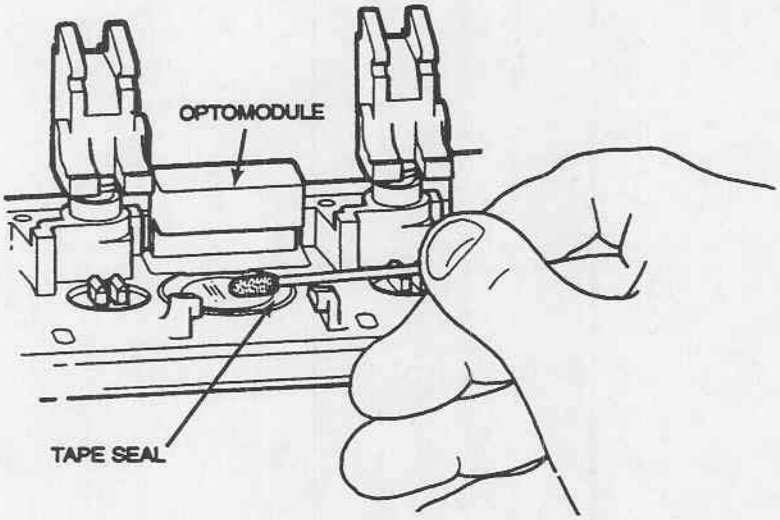
1. Gently clean the transducer surface and surrounding area with a clean swab dampened with isopropyl alcohol (Figure 7-108).

Figure 7-108. Contaminant Removal


PRESSURE TRANSDUCER

2. Cover the transducer surface with the tape seal that is included with the new transducer (Figure 7-109).

Figure 7-109. Tape Seal Application



3. Align the flat edge of the tape with the edge of the optomodule.
4. Gently press down the tape with a dry swab.

d. Reinstall in the following order.
   1. Air-in-line sensors (Section 7.4.1)
   2. Pump latch movable jaw (Section 7.3.3)
   3. Drive module (Section 7.3.5)

> **CAUTION**
>
> *Verify the proper valve actuator height (Section 7.3.6 and, if needed, adjust the pump latch height at this point (Section 7.3.2).*

   4. Chassis mounts (Section 7.3.9).
   5. Pole clamp assembly (Section 7.2.1).
   6. MEA (Section 7.5.6).
   7. Backup battery to locking two-pin connector (Section 7.5.3).
   8. Ground wire to chassis (Section 7.5.5).
   9. Display module (Section 7.5.2).
   10. Main housing assembly (Section 7.1.3).
   11. Battery pack (Section 7.1.2).
   12. Lower housing assembly (Section 7.1.1).

e. Recalibrate.
   1. All sensor systems must be recalibrated (Chapter 5).

f. Test.
   1. Perform run-in (Section 7.1) and all the functional checks (Chapter 3) except

for the battery.

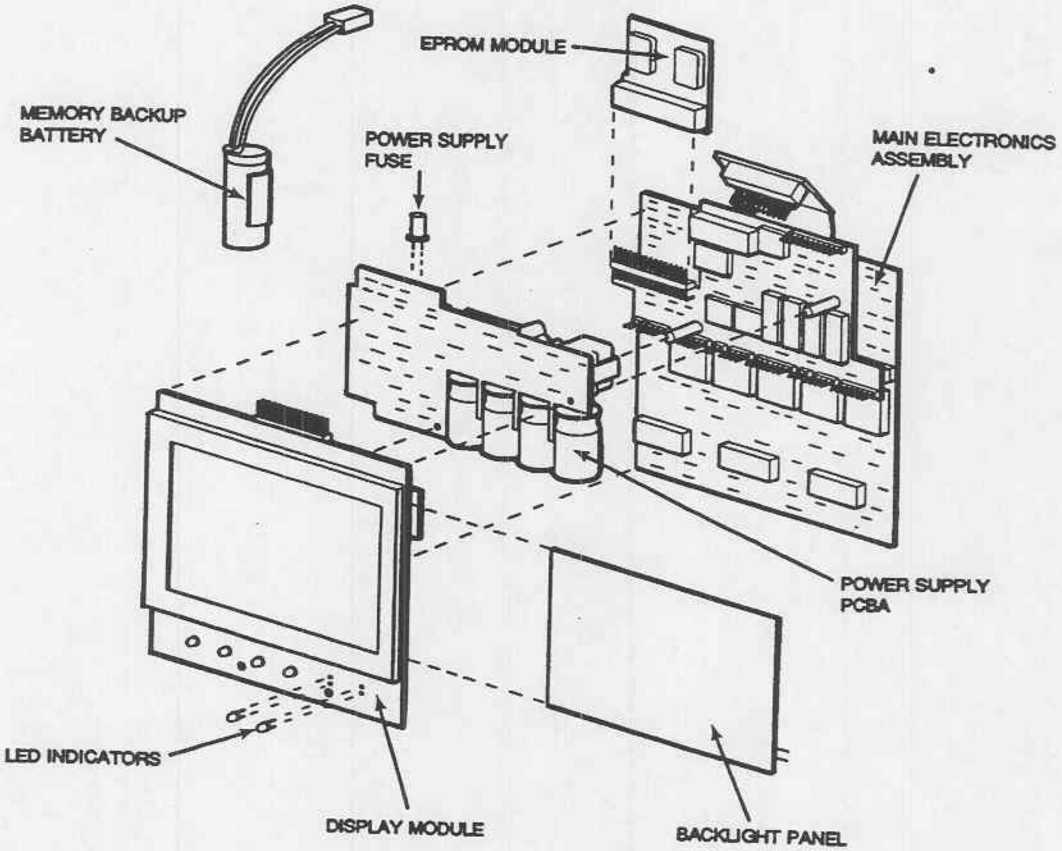
g. Restore the settings.

    1. Customized settings and the Battery History Log should be restored using FMS (refer to the FMS Directions For Use).

7.5 Electronics

An exploded view of the electronics components is shown in Figure 7-110.

Figure 7-110. Exploded View of Electrical Components (Model 2860 only)


EPROM MODULE
MEMORY BACKUP BATTERY
POWER SUPPLY FUSE
MAIN ELECTRONICS ASSEMBLY
POWER SUPPLY PCBA
LED INDICATORS
DISPLAY MODULE
BACKLIGHT PANEL

NOTE: *In this view, the Model 2863 EPROM board is reversed and the MEA board is one piece, not two.*

7.5.1 EPROM Module

Tool required: #1 Phillips screwdriver

Removal

a. First, remove the following.

    1. Battery pack (Section 7.1.2).

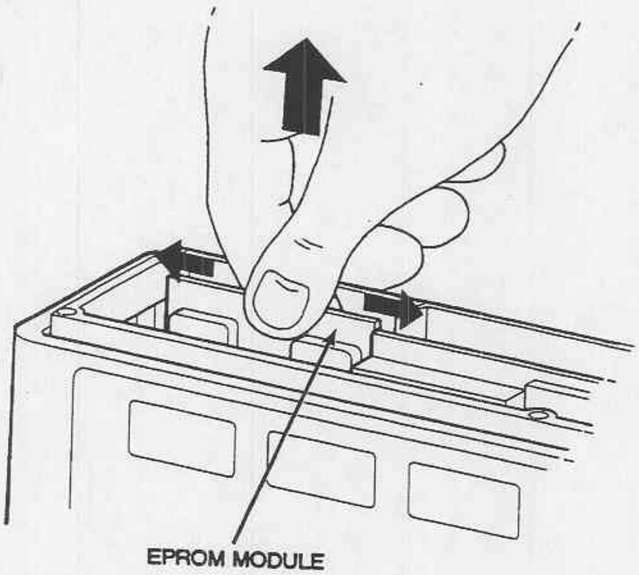
b. Remove the EPROM module

> **CAUTION**
>
> *Static charges will damage instrument circuitry. Always wear a grounded wrist strap while disassembling the instrument or while handling EPROMs. Periodically check the grounding point and wrist strap continuity.*

NOTE: *Ensure that the instrument is off before proceeding, or the instrument calibration and customized settings will be lost.*

1. Pull the EPROM module straight up (Figure 7-111). The EPROM module is mounted on a multipin connector and should not require excessive force for removal. However, a slight side-to-side movement may be required to pull it free of the connector pins.

Figure 7-111. EPROM Module Removal



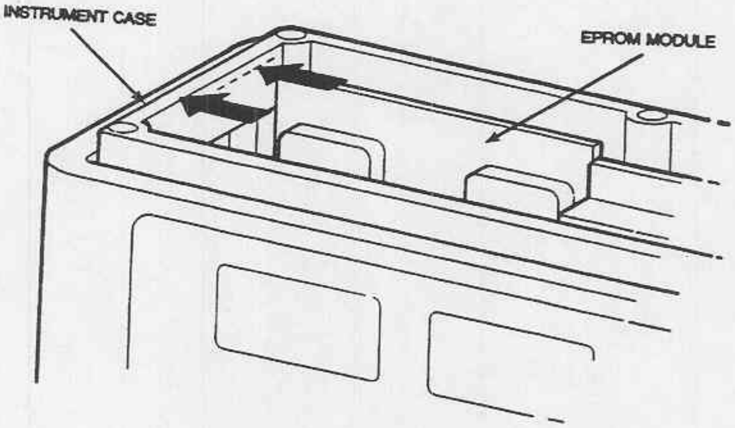
NOTE: *The Model 2863 board is reversed in this view.*

Replacement

a. Install the following.

1. Orient the module with the component side facing toward the front of the instrument for the Model 2860 and towards the rear of the instrument for the Model 2863, and insert into the multipin connector (Figure 7-112).
2. Make sure that the connector is centered and no pins protrude on either side of the module connector. Some side-to-side movement may be required to fully seat the module. When properly installed, the EPROM module will be squarely seated, and the board will be slightly lower than the flange at the top of the instrument case.

Figure 7-112. EPROM Module Insertion



NOTE: *The Model 2863 board is reversed in this view.*

3. Turn the instrument on.
4. Verify that the instrument powers up correctly.
5. Verify the software version displayed is correct.

   NOTE: *If the instrument does not power up correctly, reseat the EPROM module. Replace the module if reseating is not effective.*

b. Reassemble the battery pack (Section 7.1.2).

   NOTE: *For a complete memory self-test, the instrument should be turned on for a minimum of 10 minutes for the Model 2860 and 18 minutes for the Model 2863. It is not necessary for the unit to be pumping to perform this test. If operating on battery power, a cassette must be installed in at least one of the channels and the channel in standby mode; otherwise, the instrument will automatically shut off after 5 minutes of inactivity.*

   1. If a Watchdog 21 occurs, the EPROM module is defective and must be replaced.

7.5.2 Display Module and Component Repair

Tools required:

- #1 Phillips screwdriver
- 3/32-in. hex driver
- Grounded soldering iron
- Lint-free swabs
- Isopropyl alcohol

Disassembly

a. First, remove the following.

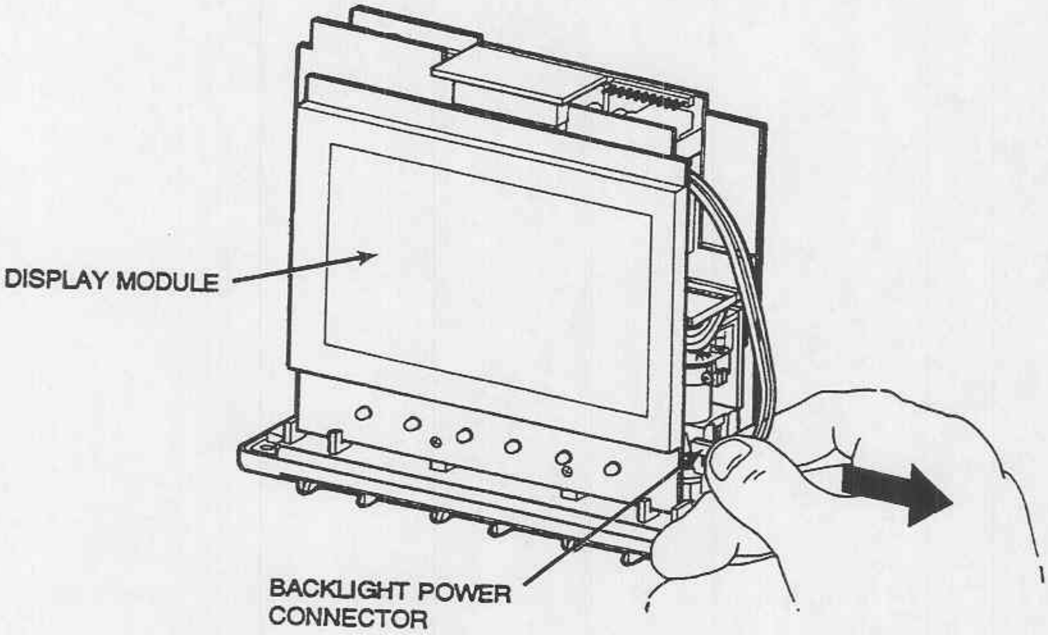
   1. Lower housing (Section 7.1.1).
   2. Battery pack (Section 7.1.2).

3. Main housing assembly (Section 7.1.3).

b. Remove the display module.

1. (For Model 2863 only) Remove the tie wrap holding the MEA top board down on the display module.
2. Remove the screws holding the display module from the chassis (on the Model 2863).
3. Unplug the backlight power connector on the side of the module (Figure 7-113).

Figure 7-113. Backlight Power Disconnection



CAUTION

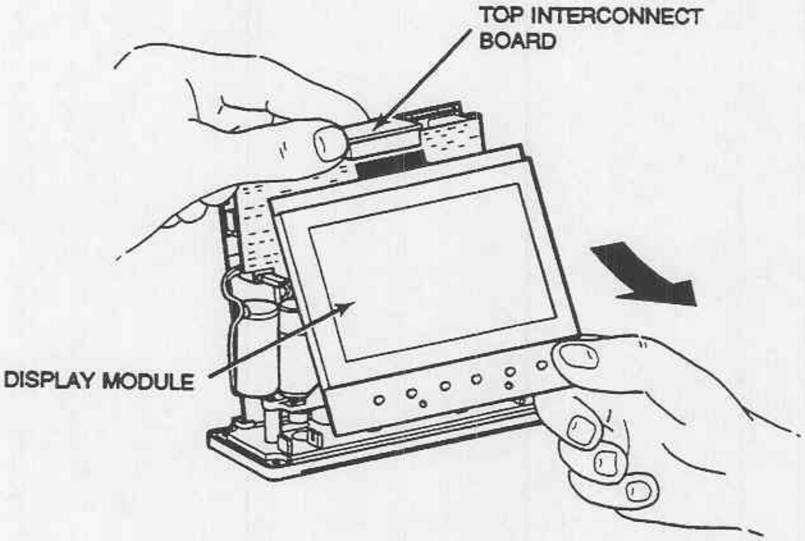
The backlight panel is powered by an 80V, 400-Hz source. Always be sure the instrument is turned off before the backlight power is disconnected from the display module.

4. Lift the module from the slots in the chassis and unplug it from the top interconnect board (Figure 7-114).

c. Inspect for the following.

1. Broken glass.
2. Damaged Kapton tape.

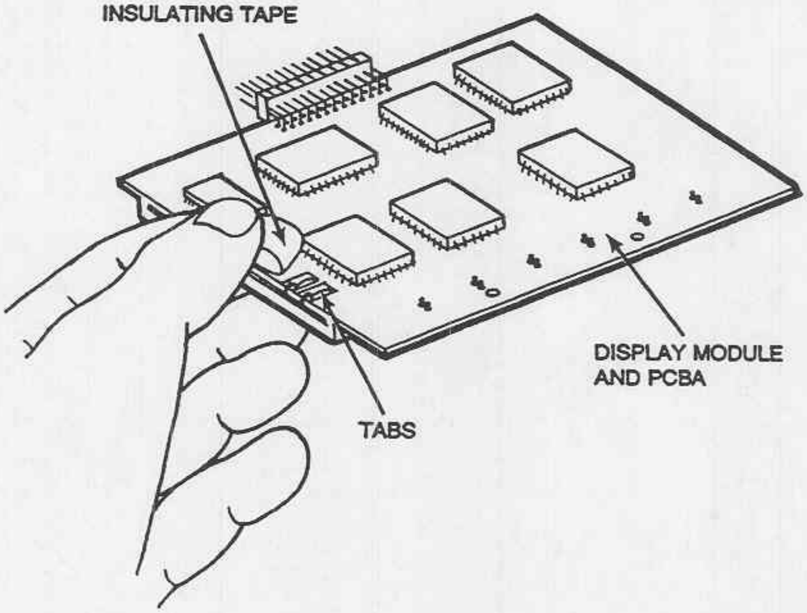
Figure 7-114. Display Module Removal


TOP INTERCONNECT BOARD
DISPLAY MODULE

d. Replace the backlight panel.

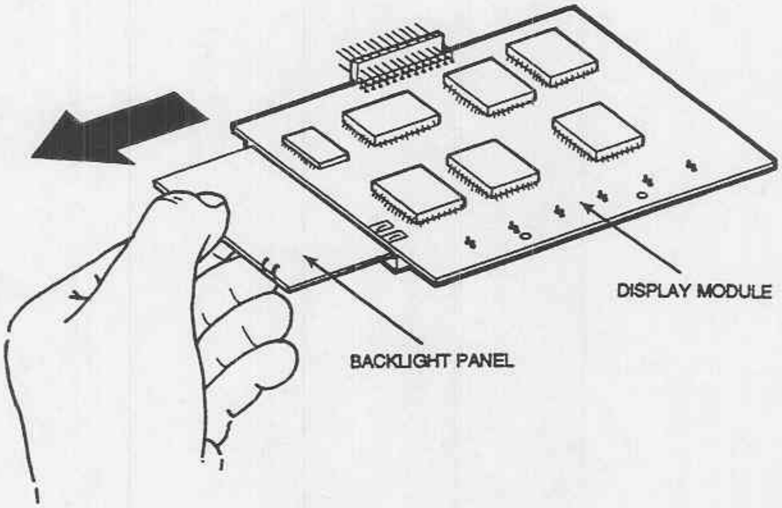
1. Remove the backlight panel by first peeling back the insulation tape to expose the two pads on the left side of the PCBA (GLASS facing down) (Figure 7-115).

Figure 7-115. Backlight Panel Tabs


INSULATING TAPE
DISPLAY MODULE AND PCBA
TABS

2. Unsolder the two tabs for the backlight panel.
3. Slide the panel out (Figure 7-116).

Figure 7-116. Backlight Panel Removal

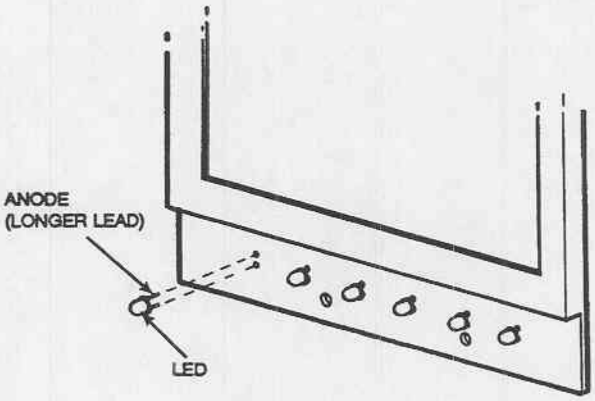


e. Replace the panel.
   1. Slide the new panels in so that the solder tabs align with the pads on the PCBA.
   2. Resolder and remove flux with isopropyl alcohol.
   3. Cover the contacts with Kapton tape.

> **CAUTION**
>
> *Do not overheat the solder tabs, as it could damage the PCBA and solder pads.*

f. Replace the LED indicator.
   1. Unsolder the desired LED.
   2. Insert the replacement LED such that the anode (longer lead) is in the bottom hole (Figure 7-117).

Figure 7-117. Display Module LED Insertion



3. Resolder and trim.
4. Remove flux with isopropyl alcohol.

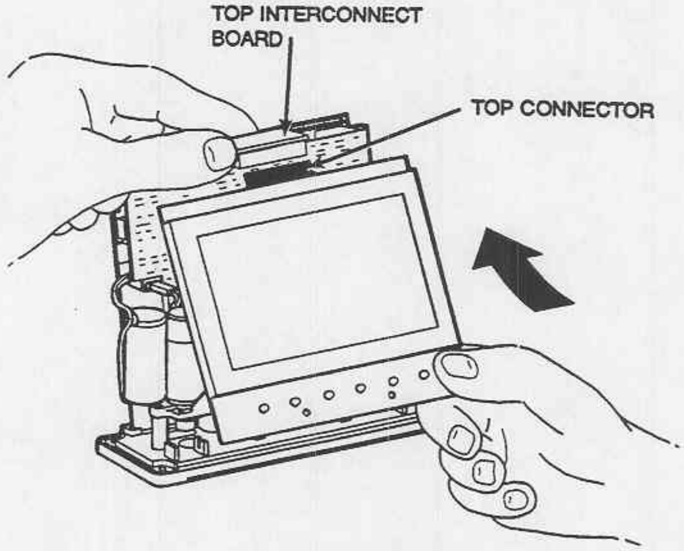
> **WARNING**
>
> *DO NOT use a substitute general purpose LED, as this could affect power supply monitoring functions.*

Reassembly

a. Reassemble in the following order.

1. Insert the top connector into the top interconnect board (Figure 7-118).

Figure 7-118. Display Module Top Connector Board Insertion



2. Replace the foam cushions at the two bottom corners of the board, if they are damaged or missing.
3. Seat the display module PCBA into the chassis slot (Figure 7-119).
4. Replace the screws, if applicable.
5. Attach the two-pin backlight power connector to the display module (Figure 7-120).
6. Ensure that the top interconnect board is properly seated.
7. (For Model 2863 only) Secure, using the tie wrap over the top interconnect board.
8. Reassemble in the following order.
    (a) Main housing assembly (Section 7.1.3).
    (b) Battery pack (Section 7.1.2).
    (c) Lower housing assembly (Section 7.1.1).

Figure 7-119. Display Module PCBA Insertion

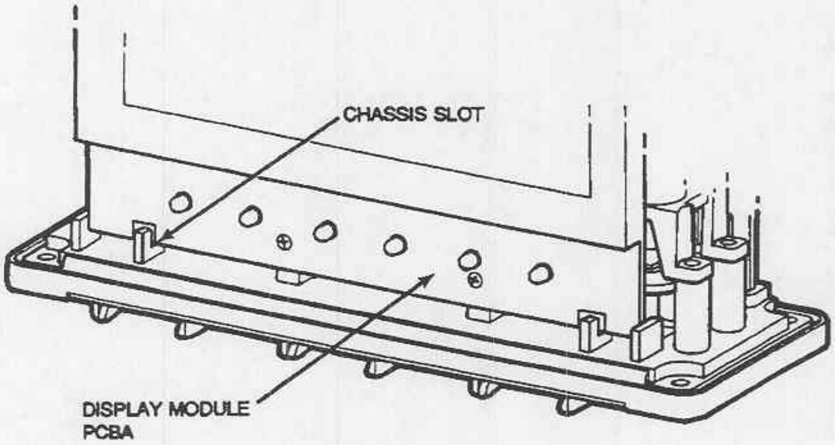
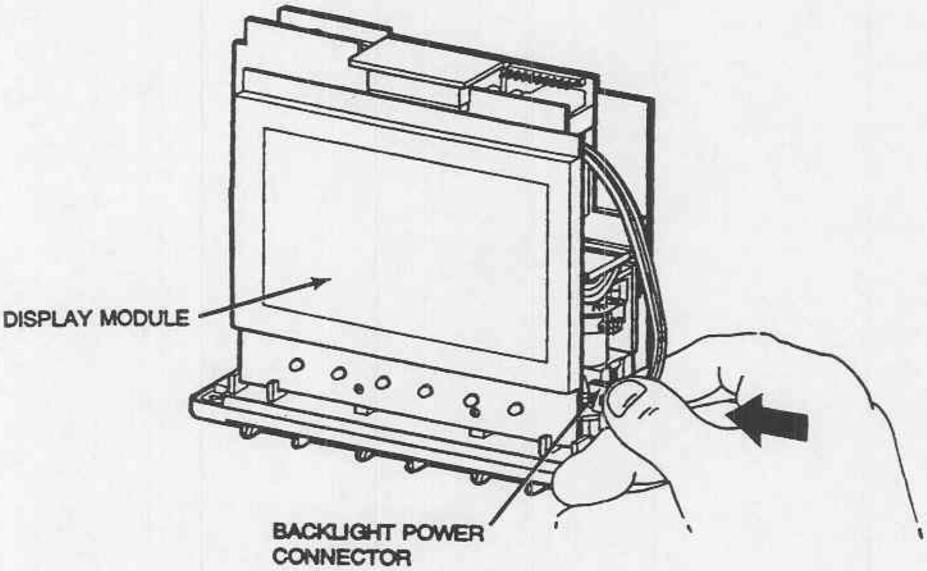

CHASSIS SLOT
DISPLAY MODULE PCBA

Figure 7-120. Backlight Power Connection


DISPLAY MODULE
BACKLIGHT POWER CONNECTOR

b. Recalibrate.

   1. Memory contents may have been corrupted or lost during handling. Recalibrate (Chapter 5) if indicated when the instrument is turned on.

c. Test.

   1. Perform run-in (Section 7.1) and all the functional checks (Chapter 3) except for the battery.

d. Restore the settings.

   1. If necessary, restore the customized settings and the Battery History Log, using FMS (refer to the FMS Directions For Use).

7.5.3 Backup Battery Replacement

Tools required:

- #1 Phillips screwdriver
- 3/32-inch hex driver

Disassembly

a. First, remove the following.

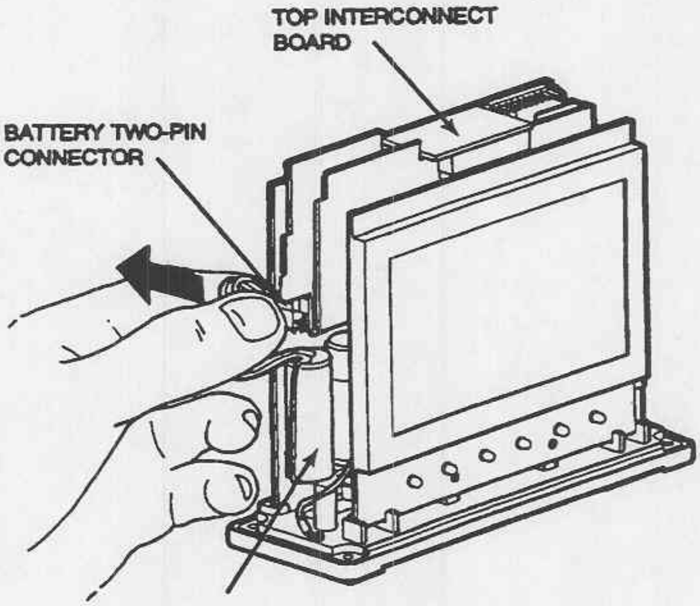
  1. Lower housing assembly (Section 7.1.1).
  2. Battery pack (Section 7.1.2).
  3. Main housing assembly (Section 7.1.3).

  NOTE: *If memory is corrupted, complete recalibration will be necessary. All custom instrument parameters originally set by using FMS will also require reprogramming.*

b. Check the voltage.

  1. To prevent memory corruption when disconnecting backup battery, a NiCad battery must be connected and the instrument must be turned on. The instrument will automatically turn off after five minutes unless a cassette is installed in at least one channel.
  2. Unplug the locking two-pin connector from the backup battery (Figure 7-121).

Figure 7-121. Backup Battery Connector



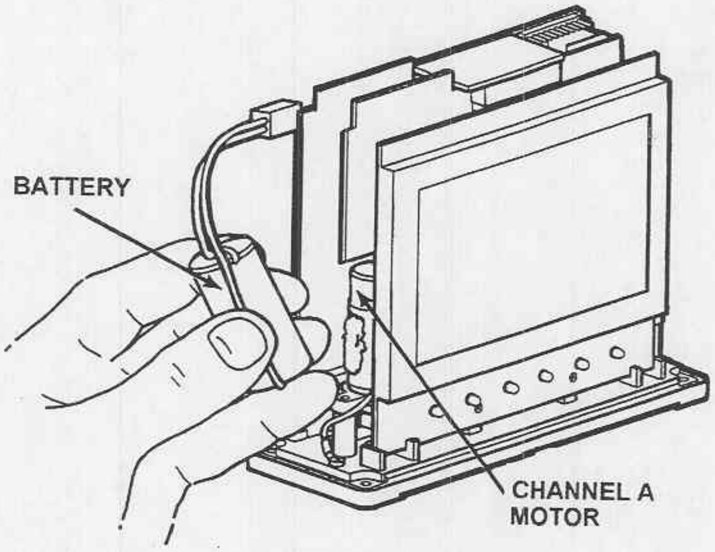
  3. Measure the terminal voltage. If less than 2.5V, replace the battery.

c. Replace the following.

  1. Remove the battery (Figure 7-122).

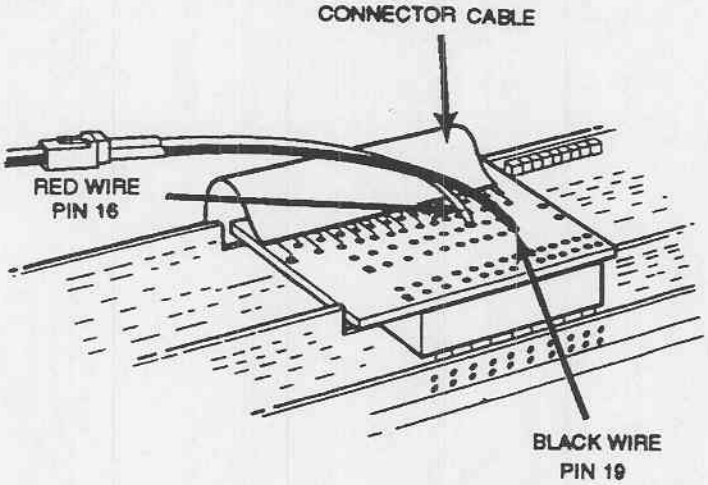
2. Remove any residual tape from the motor.
3. Remove the paper from the mounting tape and press the replacement battery to the Channel A motor.
4. Reconnect to the top interconnect board.

Figure 7-122. Backup Battery Removal


BATTERY
CHANNEL A MOTOR

d. Replace the backup battery cable assembly.
   1. Remove the battery.
      (For Model 2860 only) Remove the mounting pad from the top interconnect board.
   2. Unsolder the cable assembly from the top interconnect board (Figure 7-123).

Figure 7-123. Backup Battery Cable Assembly Soldering Locations


CONNECTOR CABLE
RED WIRE PIN 16
BLACK WIRE PIN 19

3. (For Model 2860 only) Resolder a new cable to top interconnect board. Make sure that the cables are soldered to the correct inserts.
4. Reconnect the battery to the cable assembly.

CAUTION

Use ONLY MedSystem III replacement batteries. DO NOT use any other type of battery. Doing so can damage the instrument.

Reassembly

a. Reassemble in the following order.
   1. Main housing assembly (Section 7.1.3)
   2. Battery pack (Section 7.1.2)
   3. Lower housing assembly (Section 7.1.1)

b. Recalibrate.
   1. Turn on the instrument.
   2. If the memory contents have been corrupted, recalibrate all the sensor systems (Chapter 5).

c. Test.
   1. Perform run-in (Section 7.1) and all the functional checks (Chapter 3) except for the battery.

d. Enter the battery installation date using FMS.

e. Restore the settings.
   1. If necessary, the customized settings and the Battery History Log should be restored using FMS (refer to the FMS Directions For Use).

7.5.4 Power Supply Fuse Replacement

There are two different power supply PCBA layouts. Some versions (bottom mounted) have the fuse located on the backside of the board in the lower left corner, when you are facing the display (Figure 7-124). In other versions (top mounted), the fuse is located on the top edge to the left of the top interconnect board (Figure 7-125). The same fuse is used for both versions.

CAUTION

Fuses are an off-the-shelf item. Use the following fuse manufacturer or equivalent: Little Fuse, Part No. 272003. If desired, these fuses can be purchased from IVAC. DO NOT substitute fuses of any other type or rating.

Disassembly

Tools required:
- #1 Phillips screwdriver
- 3/32-inch hex driver

Figure 7-124. Bottom-mounted Power Supply Fuse

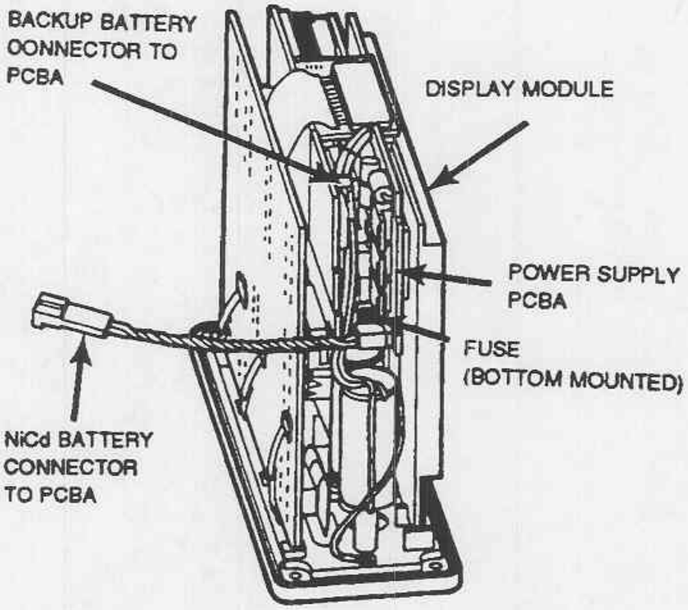
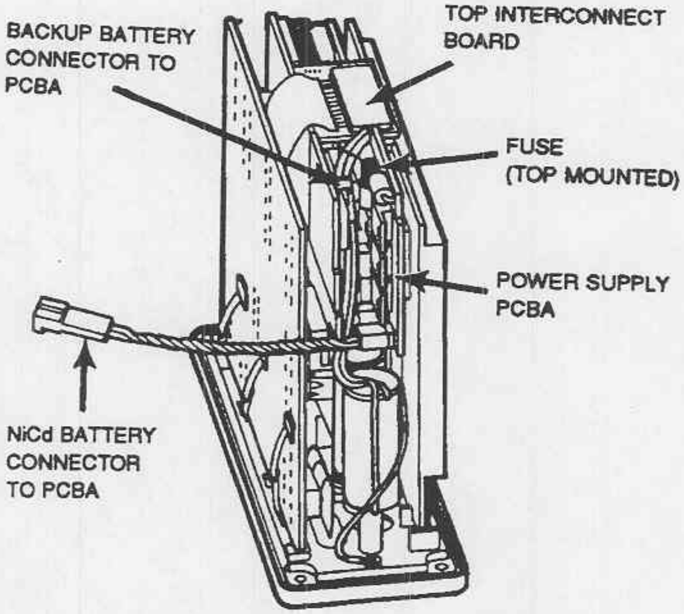

BACKUP BATTERY CONNECTOR TO PCBA
DISPLAY MODULE
POWER SUPPLY PCBA
FUSE (BOTTOM MOUNTED)
NiCd BATTERY CONNECTOR TO PCBA

Figure 7-125. Top-mounted Power Supply Fuse


BACKUP BATTERY CONNECTOR TO PCBA
TOP INTERCONNECT BOARD
FUSE (TOP MOUNTED)
POWER SUPPLY PCBA
NiCd BATTERY CONNECTOR TO PCBA

a. First, remove the following.
   1. Battery pack (Section 7.1.2).

b. Power Supply PCBA
   1. Top-mounted versions only
      (a) Remove the fuse.
      (b) Check the continuity and replace, if blown.

2. Bottom-mounted versions only
   (a) Remove the following.
   - Lower housing assembly (Section 7.1.1).
   - Unplug NiCad battery connector from power supply board.
   - Main housing assembly (Section 7.1.3).
   - Remove the fuse.

   (b) Check the fuse continuity and replace, if blown.

Reassembly

Reassemble in the following order.

a. Power supply PCBA
   1. Top-mounted versions only:
      - Battery pack (Section 7.1.2)
   2. Bottom-mounted versions only:
      - Main housing assembly (bottom-mounted version) (Section 7.1.3).
      - Battery pack (Section 7.1.2).
   3. Lower housing assembly (bottom-mounted version) (Section 7.1.1).

   Both Versions:

b. Recalibrate.
   1. Memory contents may have been corrupted or lost during handling. Recalibrate all sensor systems (Chapter 5), if indicated when the instrument is turned on.

c. Test.
   1. Perform run-in (Section 7.1) and all the functional checks (Chapter 3) except for the battery.

d. Restore the settings.
   1. The customized settings and the Battery History Log should be restored using FMS (refer to the FMS Directions For Use).

7.5.5 Power Supply PCBA

Disassembly

Tools required:

- 3/32-inch hex driver
- #1 Phillips screwdriver
- 0.050-inch hex driver

a. First, remove the following.
   1. Lower housing (Section 7.1.1).
   2. Battery pack (Section 7.1.2).
   3. Main housing assembly (Section 7.1.3).
   4. Display module (Section 7.5.2).

b. Remove the following.

  1. Using a #1 Phillips screwdriver, remove the screw securing the green ground wire from the power supply to the chassis (Figure 7-126).
  2. Remove the two power supply PCBA mounting screws, using the 0.050-inch hex driver bit (Figure 7-127).
  3. Set aside the insulating washers.

Figure 7-126. Ground Wire Disconnection

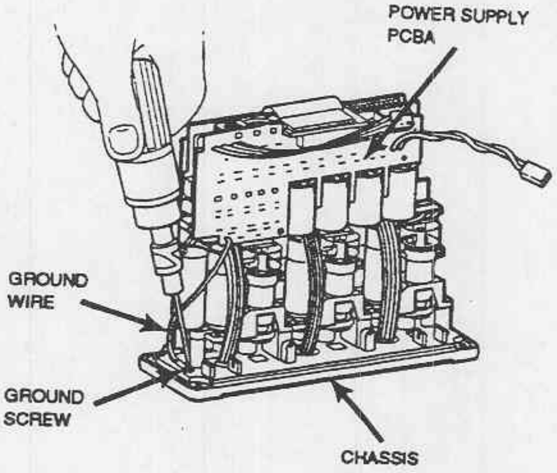
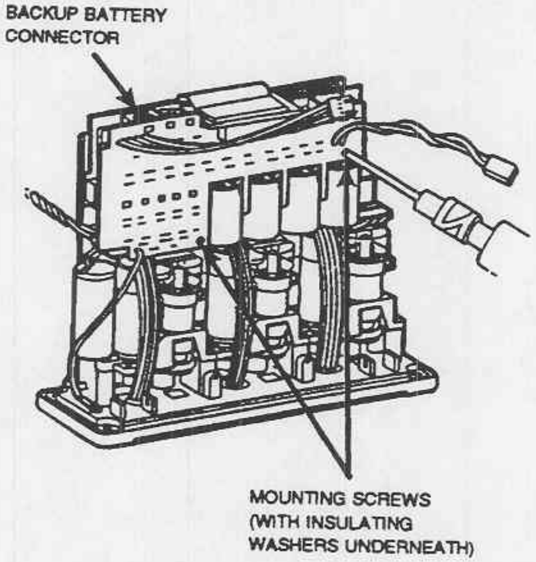

POWER SUPPLY
PCBA
GROUND
WIRE
GROUND
SCREW
CHASSIS

Figure 7-127. Power Supply PCBA Mounting Screws


BACKUP BATTERY
CONNECTOR
MOUNTING SCREWS
(WITH INSULATING
WASHERS UNDERNEATH)

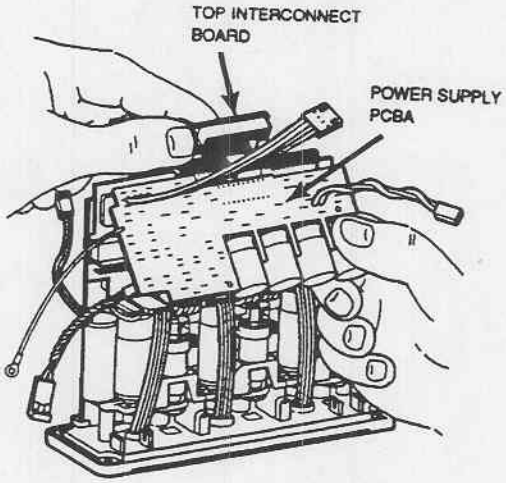
  4. Unplug the power supply from the A/C PCBA and remove (Figure 7-128).

c. Inspect for the following.

  1. Ground wire for breaks.
  2. EL backlighting connector wires.

3. Audio/connector PCBA.
4. Ensure that the inductors are securely attached to the power supply PCBA.

Figure 7-128. Power Supply PCBA Removal



Reassembly

a. Reassemble in the following order.
   1. Install the insulating washers on the mounting screws, using a 0.050-inch hex driver.
   2. Secure the PCBA to the MEA.
   3. Plug in the top interconnect board.
   4. With a ground screw and washer, attach the ground wire to the chassis, using a #1 Phillips screwdriver.
   5. Reassemble the remaining components in the following order.
      (a) Display module (Section 7.5.2).
      (b) Main housing assembly (Section 7.1.3).
      (c) Battery pack (Section 7.1.2).
      (d) Lower housing assembly (Section 7.1.1).

b. Recalibrate.
   1. All sensor systems must be recalibrated because supply voltages may have been changed (Chapter 5).

c. Test
   1. Perform run-in (Section 7.1) and all the functional checks (Chapter 3) except for the battery.
   2. Include the battery operating time if the power supply PCBA was replaced.

d. Restore the settings.
   1. The customized settings and the Battery History Log should be restored using FMS (refer to the FMS Directions For Use).

7.5.6 Main Electronics Assembly

Tools required:

- 3/32-inch hex driver
- 0.050-inch hex driver
- #1 Phillips screwdriver
- Needle-nose pliers or tweezers
- X-ACTO knife
- 0.5-inch length of 0.25-inch-diameter heat-shrink tubing (must be UL 224 or CSA 198 approved, e.g., Alpha FIT-221)

Disassembly

a. First, remove the following.
   1. Lower housing (Section 7.1.1).
   2. Battery pack (Section 7.1.2).
   3. Main housing (Section 7.1.3).
   4. Display module (Section 7.5.2).
   5. Power supply PCBA (Section 7.5.5).

b. Remove the MEA.
   1. Disconnect in order the following from the MEA.
      (a) Memory backup battery (Section 7.5.3).
      (b) Air-in-line sensors (Section 7.4.1).
      (c) Motors (Section 7.4.2).
      (d) Pressure transducers (Section 7.4.2).
      (e) Encoders (Section 7.4.2).
   2. (For Model 2863 only) Remove the screws holding the MEA to the chassis.
   3. Lift the assembly from the chassis guides and lay it on a table or other flat surface (Figure 7-129).

Figure 7-129. Main Electronics Assembly Separation from Chassis (Model 2860)

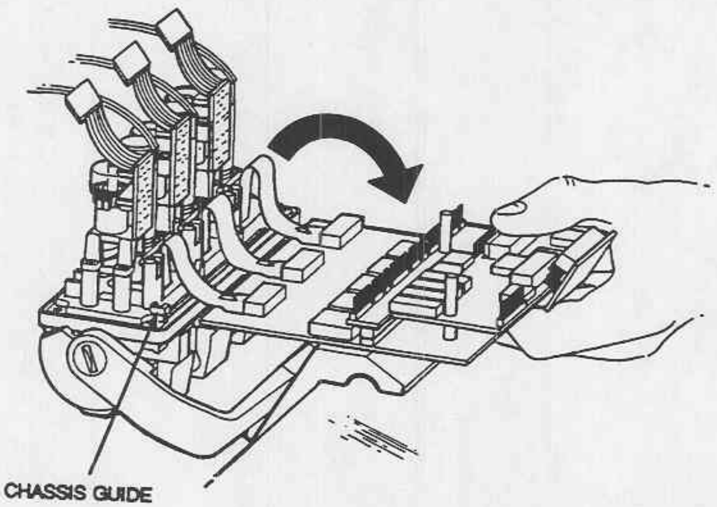
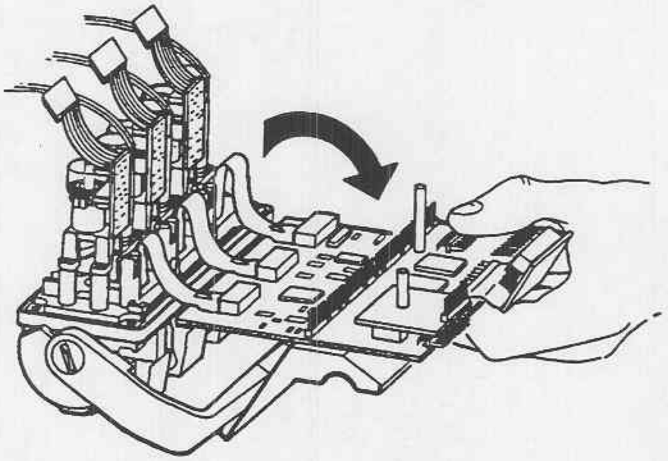
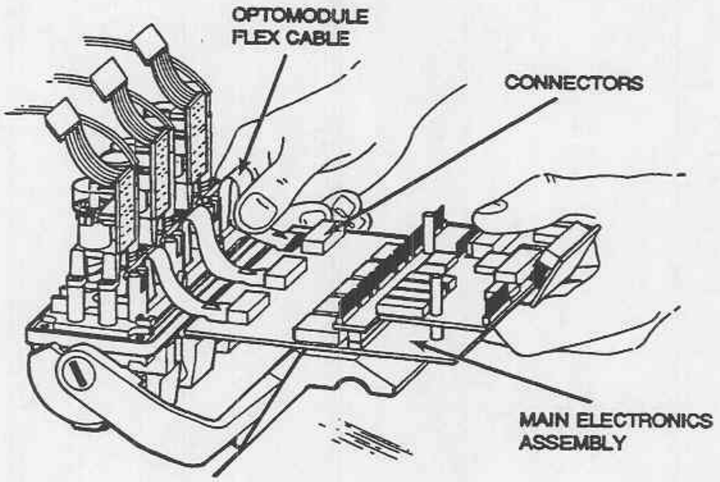


Figure 7-130. Main Electronics Asssembly Separation from Chassis (Model 2863)



4. Disconnect the optomodule flex cables from the locking connection (see Figure 7-131 and Section 7.4.2).

Figure 7-131. Optomodule Flex Disconnection



CAUTION: *(For Model 2860 only) DO NOT attempt to separate the auxiliary board from the mother board, as this requires special equipment and could cause damage.*

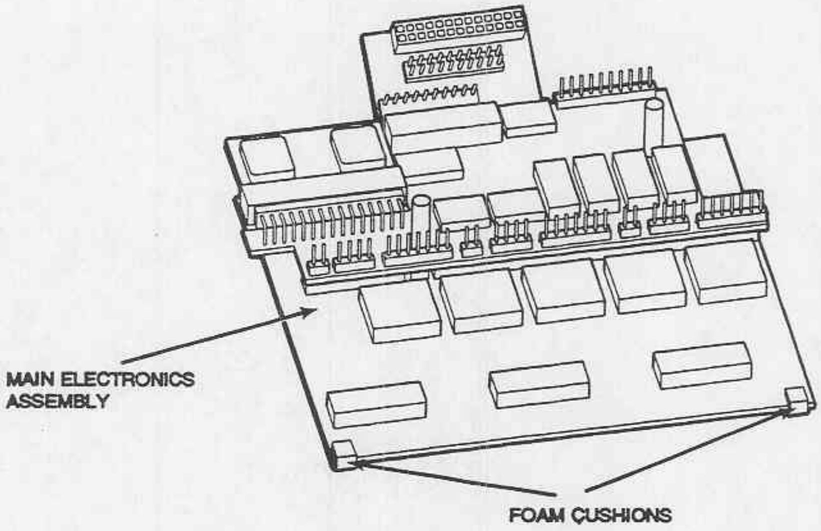
c. Inspect for the following.
   1. Loose stand-offs.
   2. Damaged foam pads on lower corners.
   3. Damaged optomodule flex cable.
   4. Damaged motor, pressure transducer, and encoder leads.
   5. Worn drive belts.
   6. Worn pump shaft sleeve bearings (if applicable).

Reassembly

a. Reassemble in the following order.

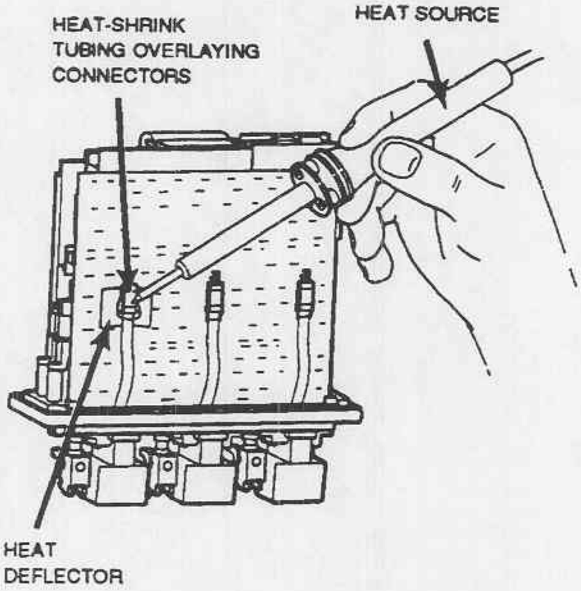
1. (For Model 2860 only) Replace the foam cushions at the two bottom corners of the board, if they are missing or damaged (Figure 7-132).

Figure 7-132. Main Electronics Assembly Foam Cushions (Model 2860 only)


MAIN ELECTRONICS ASSEMBLY
FOAM CUSHIONS

2. Insert the optomodule flex into the appropriate connector. Ensure the flexes are aligned properly and seated squarely; then seat the connector.
3. (For Model 2860 only) Slide a 0.5-inch piece of 0.25-inch UL-approved heat-shrink tubing over the air-in-line sensor flex (Figure 7-133). Mate the connector to the MEA and slide the heat-shrink to cover both connectors. Use a thin heat deflector under the connector to prevent thermal damage. Apply heat.

Figure 7-133. Heat-shrink Tubing Installation (Model 2860 only)


HEAT-SHRINK TUBING OVERLAYING CONNECTORS
HEAT SOURCE
HEAT DEFLECTOR

4. (For Model 2863 only) Connect the ultrasensor tail flexes to the main board assembly. Fold the ultrasensor tail flexes so the outside loop is down and against the circuit board. Apply a 1-1/2" ± 1/4" of 1/4" Kapton tape on the folded area.
5. Attach the remaining connectors, starting with the encoder, followed by the pressure transducer and then the motor (Figure 7-134 and 7-135). Make sure that they are oriented properly. The cables must not be crossed or twisted.
6. (For Model 2863 only) Reattach the MEA to the chassis with the screws.
7. Ensure that the pins are properly aligned.

Figure 7-134. Motor, Pressure Transducer, and Encoder Reconnection (Model 2860)

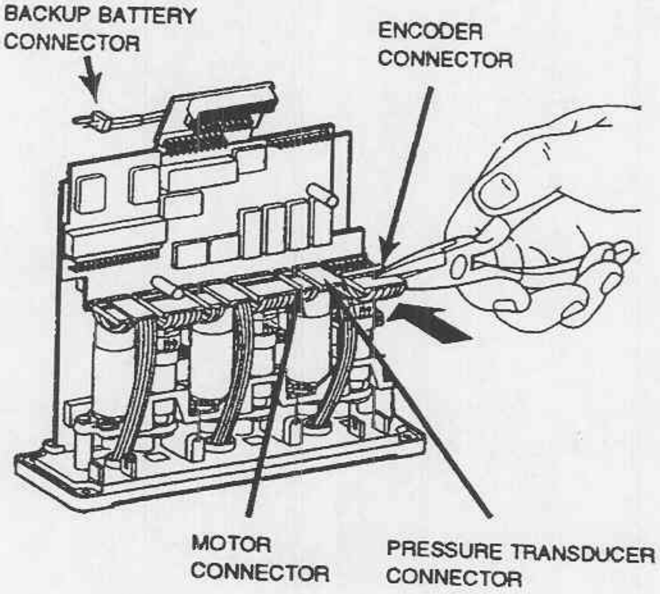
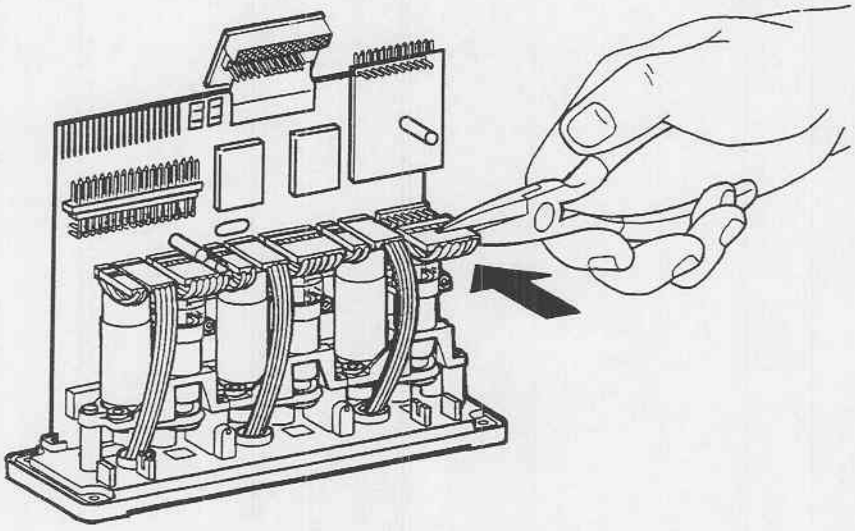

BACKUP BATTERY CONNECTOR
ENCODER CONNECTOR
MOTOR CONNECTOR
PRESSURE TRANSDUCER CONNECTOR

Figure 7-135. Motor, Pressure Transducer, and Encoder Reconnection (Model 2863)

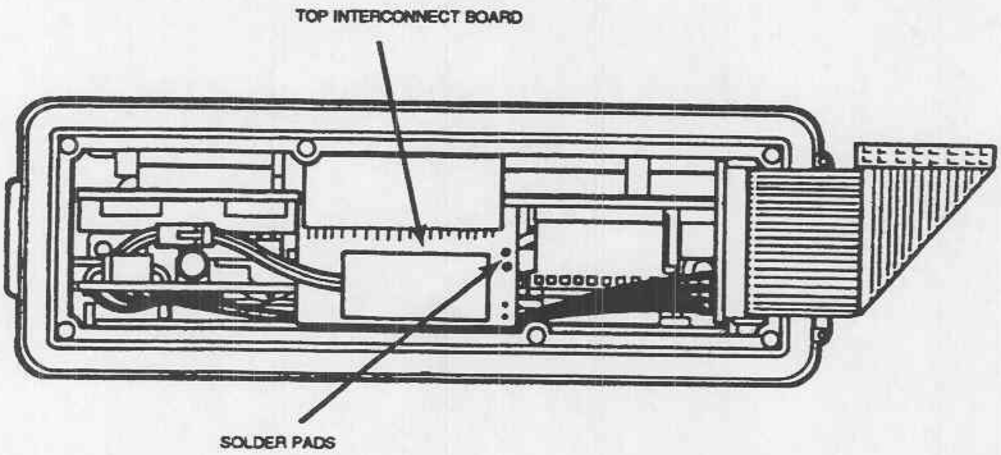


8. Reassemble the remaining components in the following order.
    (a) Power supply PCBA (Section 7.5.5).
    (b) Display module (Section 7.5.2).
    (c) Memory backup battery connector (Section 7.5.3).
    (d) Main housing assembly (Section 7.1.3).
    (e) Battery pack (Section 7.1.2).
    (f) Lower housing assembly (Section 7.1.1).

b. Reinitialize RAM (Figure 7-136).

c. Occasionally RAM contents are corrupted during normal use or after repair. The corrupted data is detected by the software and results in either an instrument fault or a watchdog. In these situations the service personnel must initialize RAM by shorting the two solder pads on the top interconnect board. Shorting these pads during power-up causes the software to initialize the RAM. After initialization the instrument must be calibrated (refer to Chapter 5), and custom parameters must be reprogrammed (refer to Troubleshooting Section 6.4.2).

Figure 7-136. RAM Initialization



d. Recalibrate.
    1. All sensor systems must be recalibrated (Chapter 5).

e. Test.
    1. Perform run-in (Section 7.1) and all the functional checks (Chapter 3) except for the battery.
    2. Include the battery operating time if the MEA was replaced.

f. Restore the settings.
    1. The customized settings and the Battery History Log should be restored using FMS (refer to the FMS Directions For Use).

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A. Technical Data

A.1 General

Standards:	ANSI/MMI ES1, 7-85. UL No. 544. CSA C22.2, No. 125, Risk Class 2G.

A.2 Physical

Outer Casing:	Polycarbonate ABS alloy.
Dimensions (H x W X D):	7.875 x 6.000 x 2.100 in. 20.00 x 15.24 x 5.33 cm.
Weights:	• Instrument: 3 lb. 9 oz. (1.61 kg.). • Universal Pole Clamp: 1 lb., 9 oz. (0.7 kg.).
Operating Temperature:	10° - 40°C.
Maximum Storage Temperature:	55°C (for optimum battery life, the preferred storage temperature is < 35°C).

A.3 Performance

Rate Range:	0.1 - 999 ml/h (per channel).
Volume Range:	0.1 - 9999 ml (per channel).
KVO Rate Range:	0.1 - 20.0 m/h.
Battery Types:	• Main: Rechargeable NiCd Battery Pack. • Memory Back-up: Nonrechargeable Lithium.
Required Administration Sets:	IVAC 25 and 28 Series Administration Sets.
Gravity Free-flow Protection:	The administration set tubing is automatically occluded when the cassette is removed from the pump, thereby minimizing the likelihood of accidental free-flow.

A.4 Electrical

Power Consumption:	6W AC power. Use only the following power sources (AC Adapter Model 1550).

A.4 Electrical (cont.)

NiCd Battery Specifications:	Running time with full charge: If battery is fully charged, minimum of 6 hours running time to *Battery Depleted* alarm, with all channels running at 125 m/h and 2 minutes of backlighting per hour. A depleted battery can be completely recharged in 14 hours, using the AC adapter. The battery retains 80% of its capacity after 500 charging cycles. The battery retains 90% of its capacity after 3 months of continuous AC charging.
Fuses:	3A fast-blow internal.
Ground Continuity:	Maximum 0.1Ω (meets UL and CSA leakage requirements).
Leakage Current:	Maximum 100 µA (per UL 544).
Overcurrent Protection:	130°F thermal cutout for AC Adapter. Self-resetting fast-blow fuse for instrument.

A.5 Mechanical Specifications

Screw Torque Specifications (in.lbf.):

Main Housing Screws	5
Air-in-line Sensor Mounting Screws	3
Drive Module Screws	5
Pump Latch Set Cup-point Screws	5
Pump Latch Set Cone-point Screws	5

Valve Actuator Height (in.):

Maximum	0.073 +0.002/-0.003
Minimum	0.032 +0.002/-0.002

Pump Latch Height (in.):

Maximum	0.112
Minimum	0.108

A.6 System Specifications

Flow Accuracy Conditions: For General Purpose I and II, Neonatal, Operating Room I and II Device Types, the system maintains ±5% flow acuracy under the following conditions:

a. Head height of -2 to +2 psi
b. Back pressure of -2 to +6 psi.

For Controller Pressure Device Types, the system maintains ±5% flow accuracy under the following conditions:

a. Head height of -4 to +4 ft H_2O
b. Back pressure of -4 to +6 H_2O.

For General Purpose I and II, Neonatal, Operating Room I and II Device Types, the system maintains ±10% flow accuracy under the following conditions:

a. Head height of -2 to +2 psi
b. Back pressure of +6 to +15 psi.

Air-in-line Sensitivity (μl):

General Purpose (GP & GP II)	Operating Room (OR & OR II)	Controller Pressure (CP)	Neonatal
100, 150, 250, 500*			<50, 50*, 75, 100

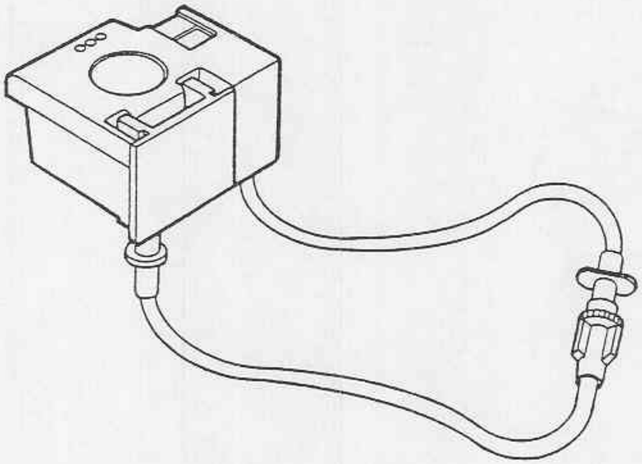
* Default Parameters

Patient-side Occlusion Detection:

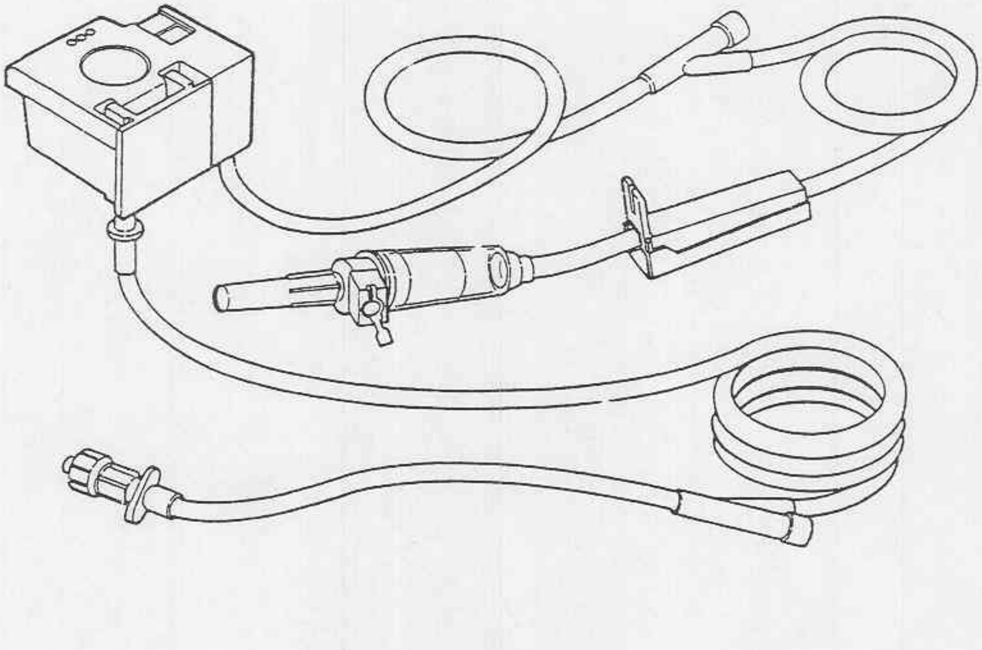
Device Type	Method	Incremental Range, psi	Maximum Range, psi
General Purpose	Baseline	1-15	4-15
General Purpose II	Baseline	1-15	4-15
Neonatal	Baseline	1-15	4-15
Controller	Absolute	N/A	1-6 ft H_2O
Operating Room	Baseline	1-15	4-15
Operating Room II	Baseline	1-15	4-15

B. Required Equipment and Supplies

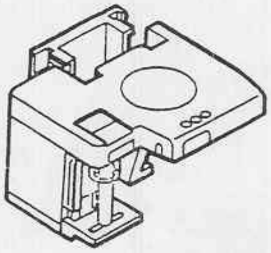
1. Fluid-filled Cassettes



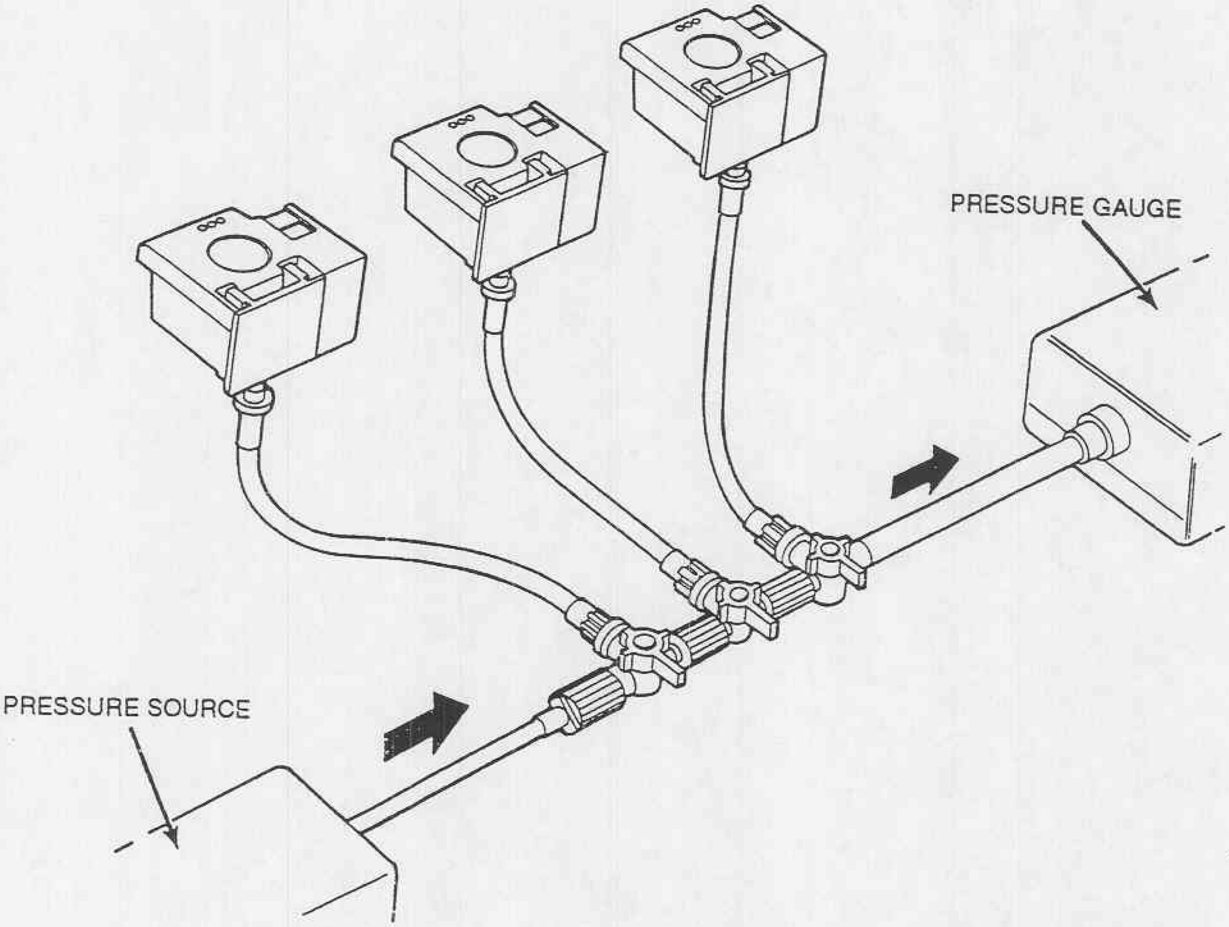
2. Administration Sets



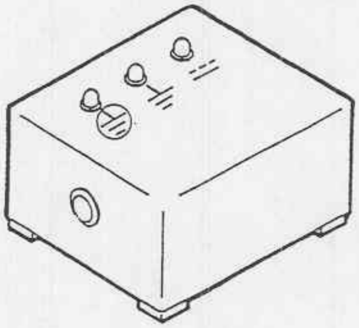
3. Cassettes Modified for Fluid-side Occlusion Calibration



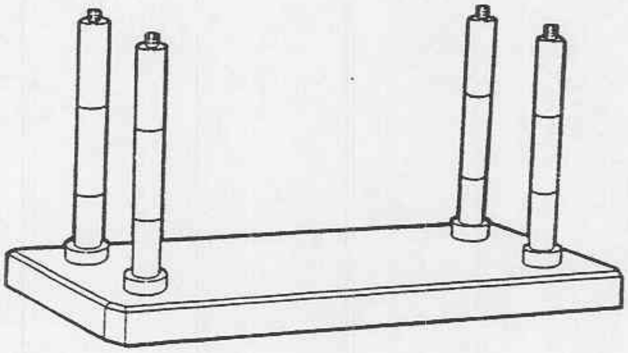
4. Cassettes Modified for Pressure Calibration


PRESSURE GAUGE
PRESSURE SOURCE

		Part No.
5.	SERVICE TOOL KIT	2861156
5A.	GAUGE BLOCK ASSEMBLY KIT	2861164
5B.	AC Adapter Tester	2861180

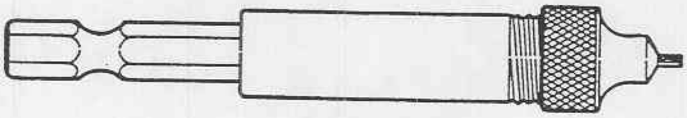


5C.	Chassis Stand	2861206

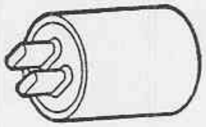


5D.	CABLE KIT:	2861222
	• Cable Assy, 2-Pin Motor	2861230
	• Cable Assy, 4-Pin Pressure	2861248
	• Cable Assy, 7-Pin Encoder	2861255
	• Cable Assy, 10-Pin Keypad	2861263
	• Cable Assy, 20-Pin Power	2861271
	• Cable Assy, 22-Pin Power	2861289
	• Cable Assy, 26-Pin LCD	2861297
5E.	3-in.lbf. Torque Driver	2861305

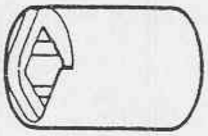
		Part No.
5F.	5-in.lbf. Torque Driver	2861313
5G.	1/4-in. Socket Driver	2861321
5H.	7/64-in. Ballpoint Hex Bit	2861354
5I.	No. 1 Phillips Bit	2861362
5J.	T-6 Torx Bit	2861370
5K.	3/32-in. Hex Bit	2861388
5L.	5/64-in. Ballpoint Hex Bit	2861347
5M.	0.05 Hex 1/4-in. Socket Bit	2861396



5N.	Guide and Seal Socket	2861404

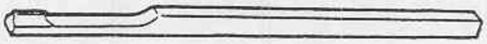


5O.	5/32-in. Socket	2861412
5P.	Dust Cap Remover Socket	2861446

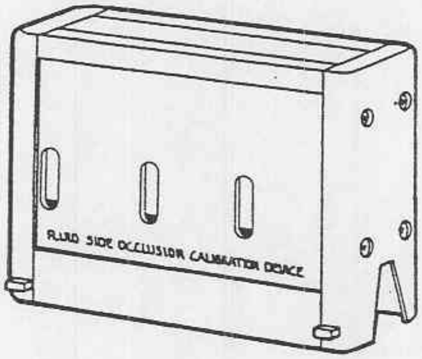


5Q.	0.05 Hex Bit Holder	2861453
5R.	0.05 Allen Key	2861420

		Part No.
5S.	5/64-in. Allen Key	2861438
5T.	Ball Plunger Adjustment Tool	2863293



5U.	Locking Ring Removal Tool	2863343
6.	Calibration Device Assembly	2861461



7.	Lint-free Swabs	
8.	Tweezers	
9.	Needle Nose Pliers	
10.	X-acto Knife	
11.	Nonmetallic Scraper	
12.	FIELD MAINTENANCE SOFTWARE KIT:	
	• Version 2.1 (without Dose Rate Calculator)	2861107
	• Version 2.2 (with Dose Rate Calculator)	2860525

This kit includes:

- Floppy Disk (3-1/2" or 5-/14") with FMS
- RS-232 cable with MedSystem III connector
- 9- to 25-pin (female to male) adapter

13. IBM PC or compatible with a minimum of 12K memory and DOS 3.0 or higher
14. Leakage current and ground continuity tester

Part No.

15. Oscilloscope with 10X probe
16. 5V and 13V DC power supply
17. Volumetric glass burette (class A)
18. Stopwatch (0.1 second precision)
19. Clean and dry compressed air source
20. Air Pressure source up to 15.0 psig.
21. Pressure gauge
22. Grounded soldering iron
23. Silicone sealant (Dow Corning 739 or equivalent)
24. Magnalube-G Teflon grease
25. Isopropyl alcohol
26. Loctite Assure 425 surface curing thread locker
27. Loctite Primer "N"
28. Loctite 518 gasket eliminator
29. 0.25-in. diameter heat shrink tubing
    (must be UL 224 or CSA 198 approved,
    e.g., Alpha FIT-221).
30. Loctite 401 Superbonder

C. Recommended Spare Parts

	Description	Order No.
1.	TOP LABEL KIT	2860505
2.	Top Seal	2860513
3.	LOWER HOUSING KIT	2860521
4.	Lower Housing Clips	2860539
5.	Bottom Seal	2860547
6.	PAD KIT	2860596
7.	DUST CAP KIT	2860604
8.	Display Module	2860620
9.	3A Fuse (5 per box)	2860653
10.	BATTERY PACK ASSEMBLY KIT	2860703
11.	MEMORY BACKUP BATTERY KIT	2860729
12.	DRIVE MODULE KIT	2860745
13.	Drive Belts (3 per package)	2860752
14.	PUMP LATCH ASSEMBLY KIT	2860794
15.	Slide Links	2860828
16.	Optomodule Assembly	2860851
17.	Pole Clamp Chassis Mount Assembly	2860869
18.	POLE CLAMP KNOB ASSEMBLY KIT	2860877
19.	PRESSURE TRANSDUCER KIT	2860919
20.	HARDWARE KIT	2861081
21.	A/C Adapter	2861099
22.	A/C Adapter Clip	2861065
23.	LCD Backlight	2861131
24.	Pump Shaft Seal	2860844
25.	AUDIO/CONNECTOR PCBA KIT	2860612

	Description	Order No.
26.	POWER PCBA KIT	2860646
27.	AIR-IN-LINE SENSOR KIT (Model 2860)	2860802
28.	AIR-IN-LINE SENSOR KIT (Model 2863)	2860516
29.	Knob Assembly Slide Cap	2863079
30.	Bearing Clip	2861149
31.	MAIN ELECTRONIC ASSY KIT (Model 2863)	2860514
32.	DISPLAY MODULE/MEA MNTG SCREWS KIT	2860515
33.	3.5 EPROM KIT (Model 2863)	2860517
34.	MALE/FEMALE STANDOFFS KIT	2860518
35.	CABLE TIE KIT (Model 2863)	2860519
36.	LOWER HOUSING KIT	2860521
37.	Main Housing Partial Assembly	2860554
38.	Main Housing with Audio PCBA	2860562
39.	GRAPHIC LABEL KIT	2860588
40.	LED KIT	2860638
41.	3.3D EPROM UPGRADE KIT (Model 2860)	2860661
42.	Main Electronics Service Assy (Model 2860)	2860679
43.	Battery Cap Cable Service Assembly	2860711
44.	Backup Cable Memory Assembly	2860737
45.	MOTOR KIT	2860760
46.	Dust Cover Encoder	2860778
47.	VALVE ACTUATOR KIT	2860786
48.	Pump Shaft Service Assembly	2860836
49.	Slide Knob Assembly	2860885
50.	CONNECTOR REPAIR KIT	2860893
51.	MOTOR ASSEMBLY SCREW KIT	2860935
52	Drive Module Screws	2860943
53.	Air-in-line Sensor Screws	2860950

	Description	Order No.
54.	Pole Clamp Chassis Mount Screws	2860968
55.	Female Standoffs	2860976
56.	Mounting Standoffs	2860984
57.	Power PCBA/MEA Screws	2861008
58.	Battery Pack Screws	2861016
59.	Main Housing Mounting Screws	2861024
60.	PCBA/MEA Power Insulating Washers	2861032
61.	Pole Clamp Index Screws	2861040
62.	Motor Cleats	2861057
63.	LATCH ASSEMBLY PUMP SCREW KIT	2861073
64.	LOCKING AC ADAPTER KIT	2861089
65.	LOCKING AC ADAPTER CONVERSION KIT	2861090
66.	Non-locking AC Adapter	2861099
67.	Universal Pole Clamp	2861123

D. BATTERY HISTORY LOG

D.1 Using the Battery History Log

The Battery History Log contains information useful in performing battery operating time functional checks, annual maintenance, and troubleshooting. It also provides information on how the instrument is powered, such as time on AC, time on battery, and number of cycles. This log is available in software versions 3.1 and higher. The BATLOG soft key is accessed by pressing the MORE OPTIONS key from the Standard Display page. Pressing the BATLOG soft key displays the following screen.

```
                    BIOMED BATTERY HISTORY

   NiCd date                          Li date
   Nlba             Nbda              Nelp              Npsf
   Tac              Tbatt             Nc                Nd
   Date             Tlba              Tbda              Telp
   Date             Tlba              Tbda              Telp
   Date             Tlba              Tbda              Telp

                    PRESS STANDARD DISPLAY
```

Row 1

NiCd date: Installation date for the NiCd battery.

Li date: Installation date for the lithium backup battery.

Row 2

Nlba: Number of low battery advisories.

Nbda: Number of battery depleted alarms.

Nelp: Number of times the instrument shut off due to extremely low-battery power, which happens if AC power is not applied after a battery-depleted alarm.

Npsf: Number of Power System Failure advisories (Event Code 534).

Row 3

Tac: Total time in minutes that the instrument was operated on AC power.

Tbatt: Total time in minutes that the instrument was operated on battery power.

Nc: Number of charge cycles as defined by starting from a voltage below the level for the low-battery advisory to a full-charge voltage (3.95V).

Nd: Number of discharge cycles as defined by starting from a voltage above the full-charge level (3.95V) to a voltage level below the low-battery advisory.

Rows 4 through 6

These three rows show a history of the last three discharge events.

Row 4 is the most recent discharge event. Row 5 is the next most recent discharge event. Row 6 is the third most recent discharge event.

Date:	The date the discharge event was initiated.
Tlba:	Time (minutes) from start of battery operation to the low-battery advisory.
Tbda:	Time (minutes) from the low-battery advisory to the battery-depleted alarm.
Telp:	Time (minutes) from the battery-depleted alarm to instrument shutoff.

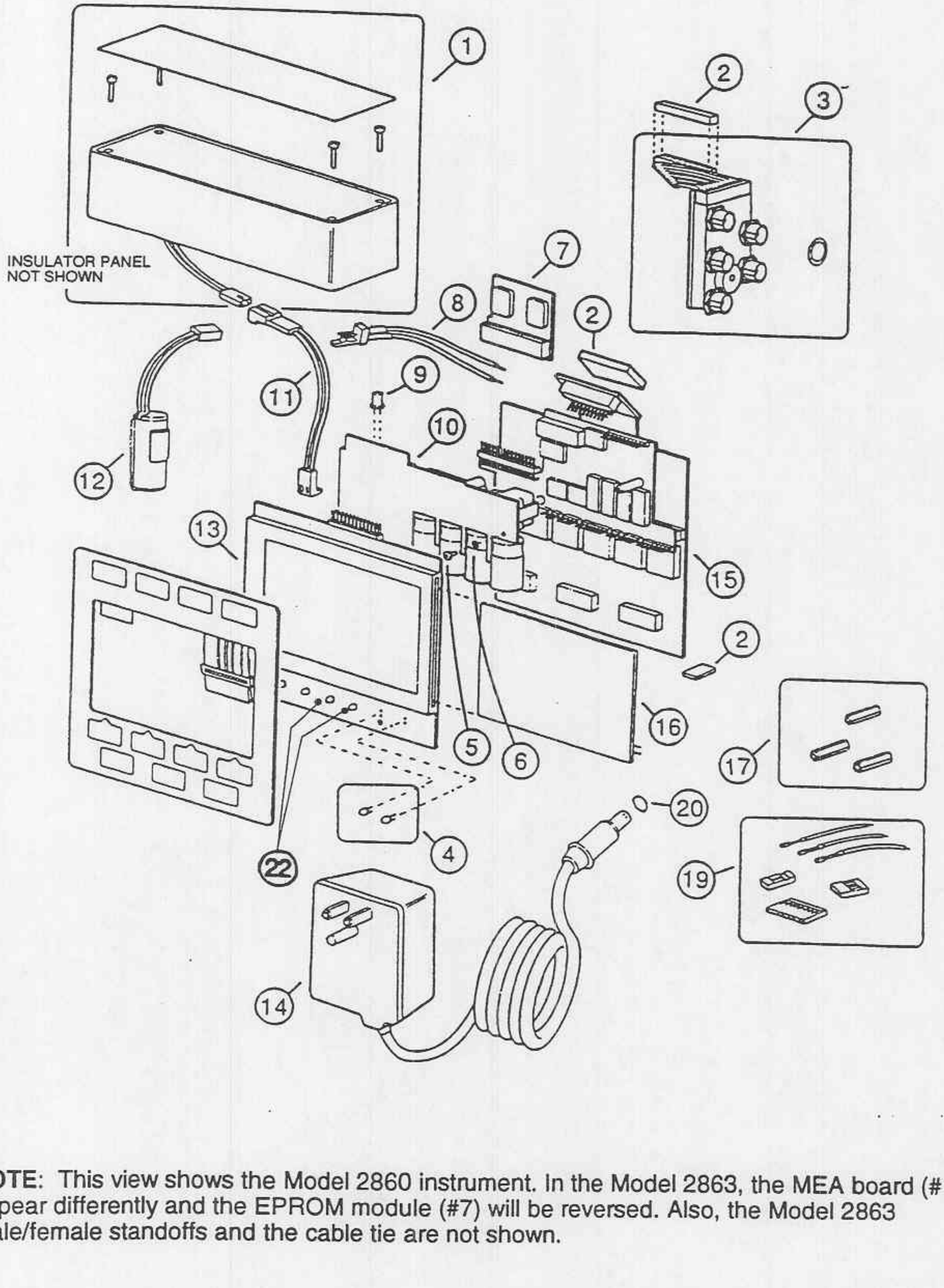
D.2 Clearing

The Battery History Log must be cleared at initial installation of certain components, or if memory contents are corrupted. The latter happens during replacement of the backup battery and can happen during disassembly. Installation date codes that have not been set are displayed as dashes. If the Log is not cleared when required, then the data are erroneous, and very large or negative numbers may be displayed.

ELECTRICAL COMPONENTS

	Description	**Spare Part No.**	**Replacement No.**
1	Battery Pack Assembly Kit 6140 01 467 5832	2860703	
2	Pad Kit	2860596	
3	Audio/Connector PCBA Kit	2860612	
4	LED kh, 4 green and 3 red/pkg.	2860638	
5	Power PCBA/MEA Screws, 20/pkg.	2861008	
6	Insulating Washers, Power PCBA/MEA, 20/pkg.	2861032	
7a	EPROM Module, 1MB, Programmed PCBA (Model 2860)	2860661	
7b	EPROM Module, 1MB, Programmed PCBA (Model 2863)	2860517	
8	Memory Backup Battery Cable Assembly	2860737	
9	3A Fuse, 5/pkg.	2860653	
10a	Power PCBA Kit (Reconditioned Board Assy)	2860646	
10b	Power PCBA Kit (New Board Assy) Eff. 6/95	2860531	
11	Battery Pack Cable Assembly	2860711	
12	Memory Backup Battery Kit	2860729	
13	Display Module	2860620	
14	AC Adapter	2861099	
15a	Main Electronics Assembly Kit (Model 2860)	2860679	
15b	Main Electronics Assembly Kit (Model 2863)	2860514	
16	LCD Back Light	2861131	
17	Female Standoffs, 20/pkg.	2860976	
18	Male/Female Standoffs (Model 2863)	2860518	
19	Connector Repair Kit	2860893	
20	AC Adapter Locking Ring, 50/pkg.	2863061	
21	Display Module/MEA Mounting Screws (Model 2863)	2860515	
22	Cable Tie (Model 2863)	2860519	

ELECTRICAL COMPONENTS

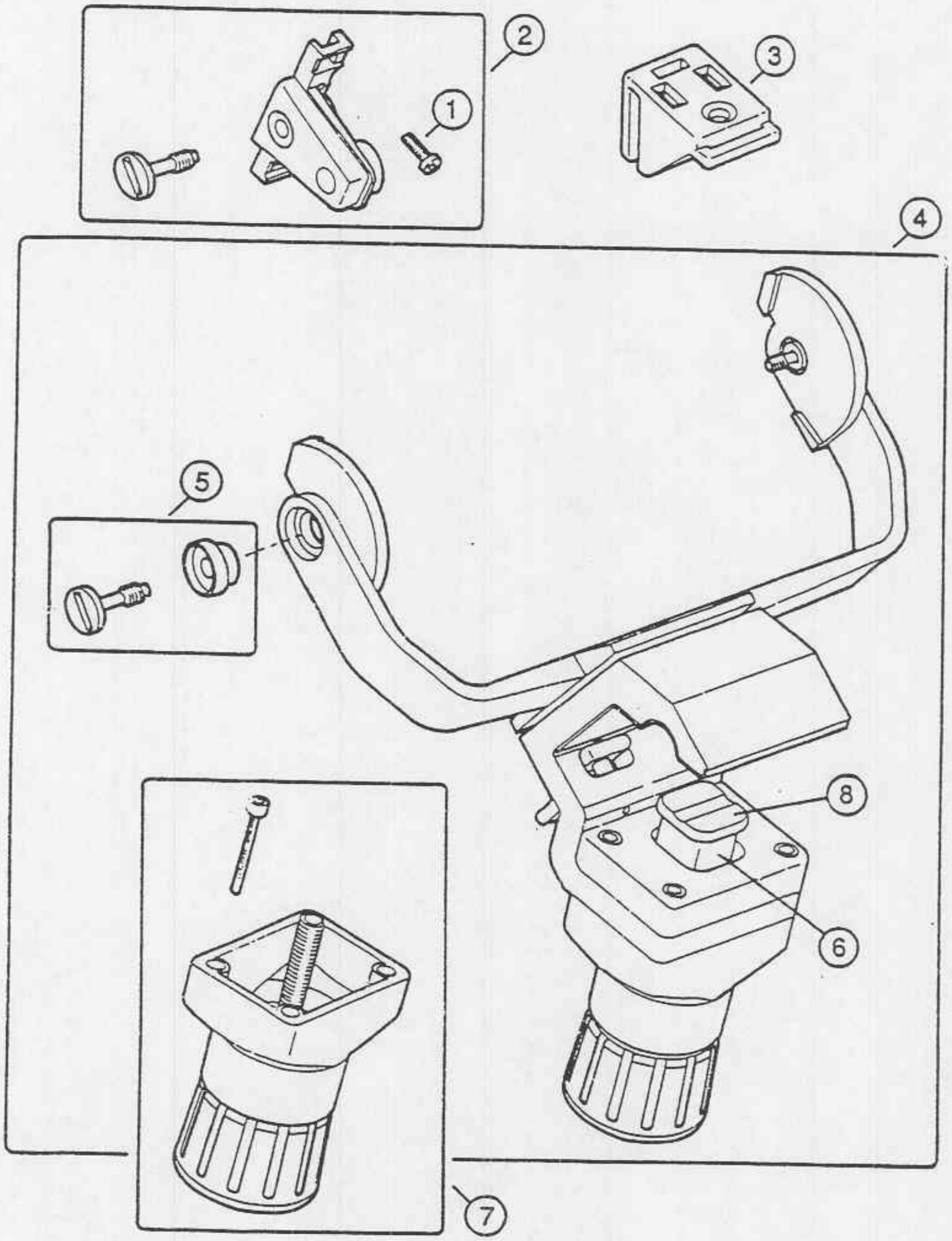

1
2
3
INSULATOR PANEL NOT SHOWN
7
8
2
9
11
10
12
13
15
2
16
5
6
17
20
4
22
19
14

NOTE: This view shows the Model 2860 instrument. In the Model 2863, the MEA board (#15) will appear differently and the EPROM module (#7) will be reversed. Also, the Model 2863 male/female standoffs and the cable tie are not shown.

POLE CLAMP COMPONENTS

	Description	**Spare Part No.**	**Replacement No.**
1	Pole Clamp Chassis Mount Screws, 40/pkg.	2860968	
2	Pole Clamp Chassis Mount Assembly Kit	2860869	
3	AC Adapter Clip	2861065	
4	Universal Pole Clamp Kit	2861123	
5	Pole Clamp Index Screw Kit, 20 sets/pkg.	2861040	
6	Knob Assembly Slide Kit	2860885	
7	Knob Assembly Kit	2860877	
8	Knob Assembly Slide Cap	2863079	

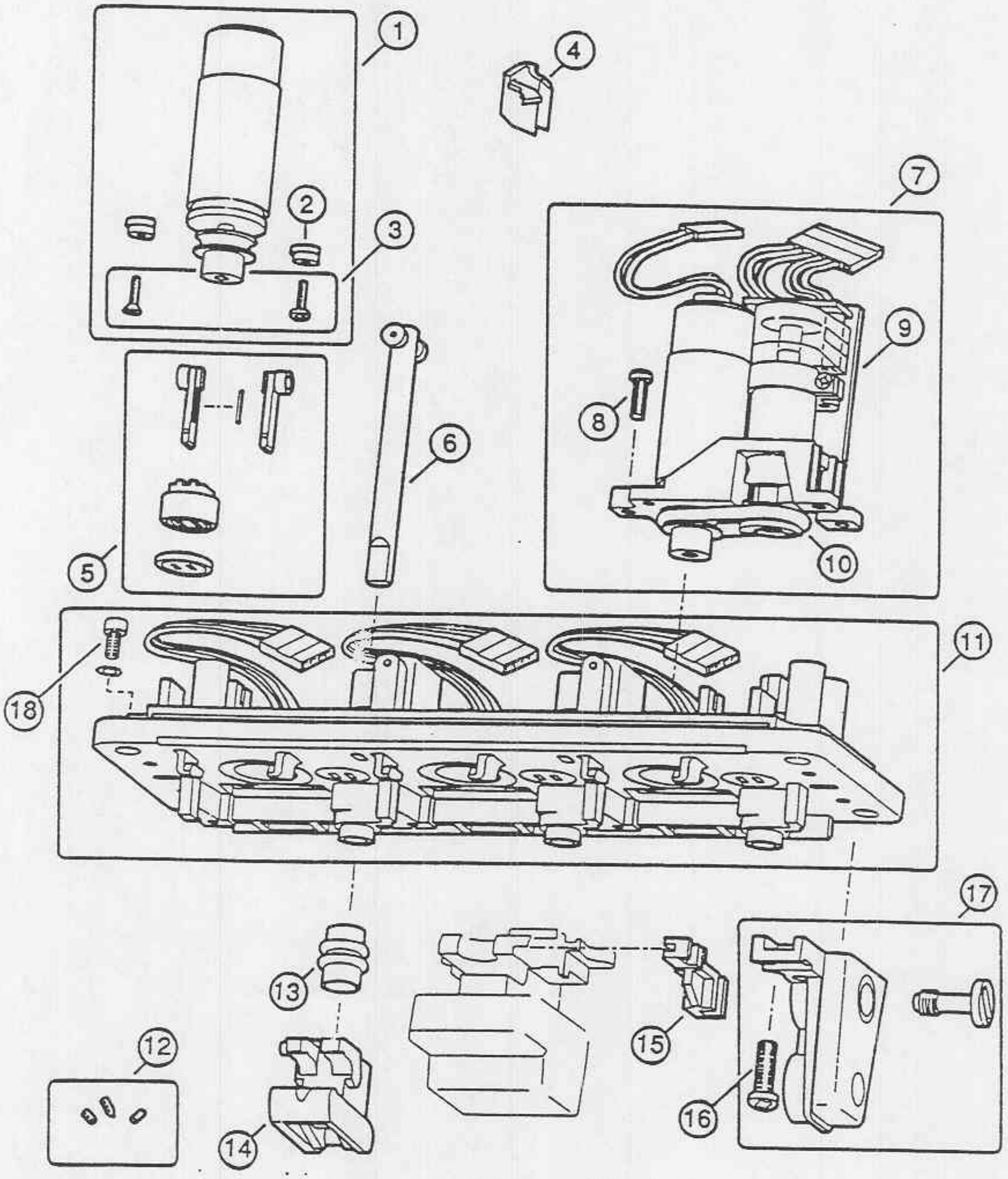
POLE CLAMP COMPONENTS



MECHANICAL COMPONENTS

	Description	Spare Part No.	Replacement No.
1	Motor Kit	2860760	
2	Motor Cleats, 60/pkg.	2861057	
3	Motor Assembly Screw Kit, 30 sets/pkg.	2860935	
4	Bearing Clips, 30/pkg.	2861149	
5	Valve/Actuator Kit	2860786	
6	Pump Shaft Assembly	2860836	
7	Drive Module Kit	2860745	
8	Drive Module Screws, 90/pkg.	2860943	
9	Encoder Dust Cover	2860778	
10	Drive Belt, 3/pkg.	2860752	
11	Chassis Assembly (not available)	2860901	
12	Pump Latch Assembly Screw Kit, 30 sets/pkg.	2861073	
13	Pump Shaft Seal, 3/pkg.	2860844	
14	Pump Latch Assembly Kit	2860794	
15	Slide Link, 3/pkg.	2860828	
16	Pole Clamp Chassis Mount Screws, 40/pkg.	2860968	
17	Pole Clamp Chassis Mount Assembly Kit	2860869	
18	Chassis Ground Screw/Washer	2863129	

MECHANICAL COMPONENTS


1
2
3
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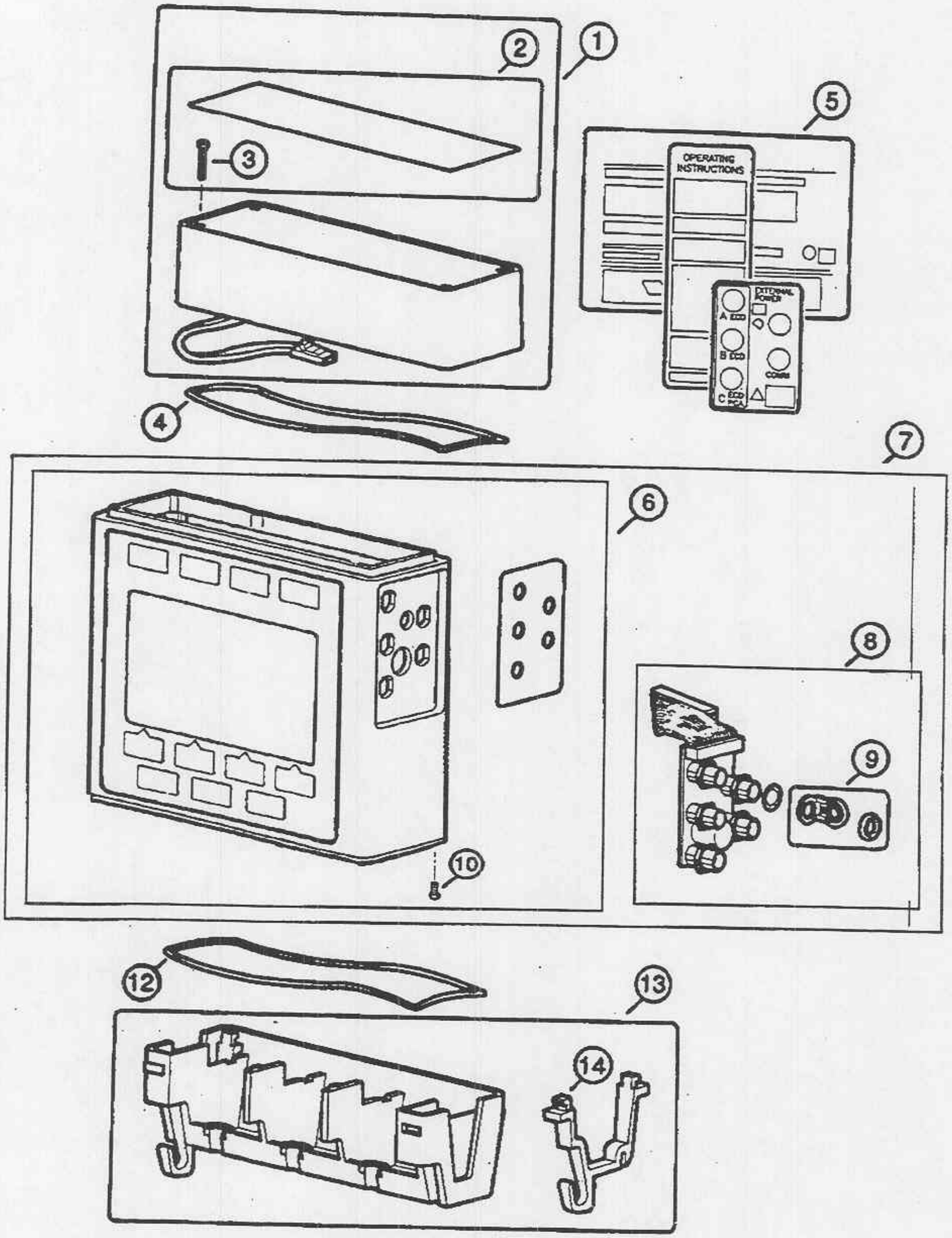
16
17
18

HOUSING COMPONENTS

	Description	**Spare Part No.**	**Replacement No.**
1	Battery Pack Assembly Kit	2860703	
2	Top Label Kit	2860505	
3	Battery Pack Screws, 40/pkg.	2861016	
4	Top Seal	2860513	
5	Graphic Label Kit	2860588	
6	Main Housing Partial Assembly (without Audio/Connector PCBA)	2860554	
7	Main Housing Assembly (with Audio/Connector PCBA)	2860562	
8	Audio/Connector PCBA Kit	2860612	
9	Dust Cap Kit	2860604	
10	Main Housing Mounting Screws, 40/pkg.	2861024	
12	Bottom Seal	2860547	
13	Lower Housing Kit	2860521	
14	Lower Housing Clip, 2/pkg.	2860539	

HOUSING COMPONENTS

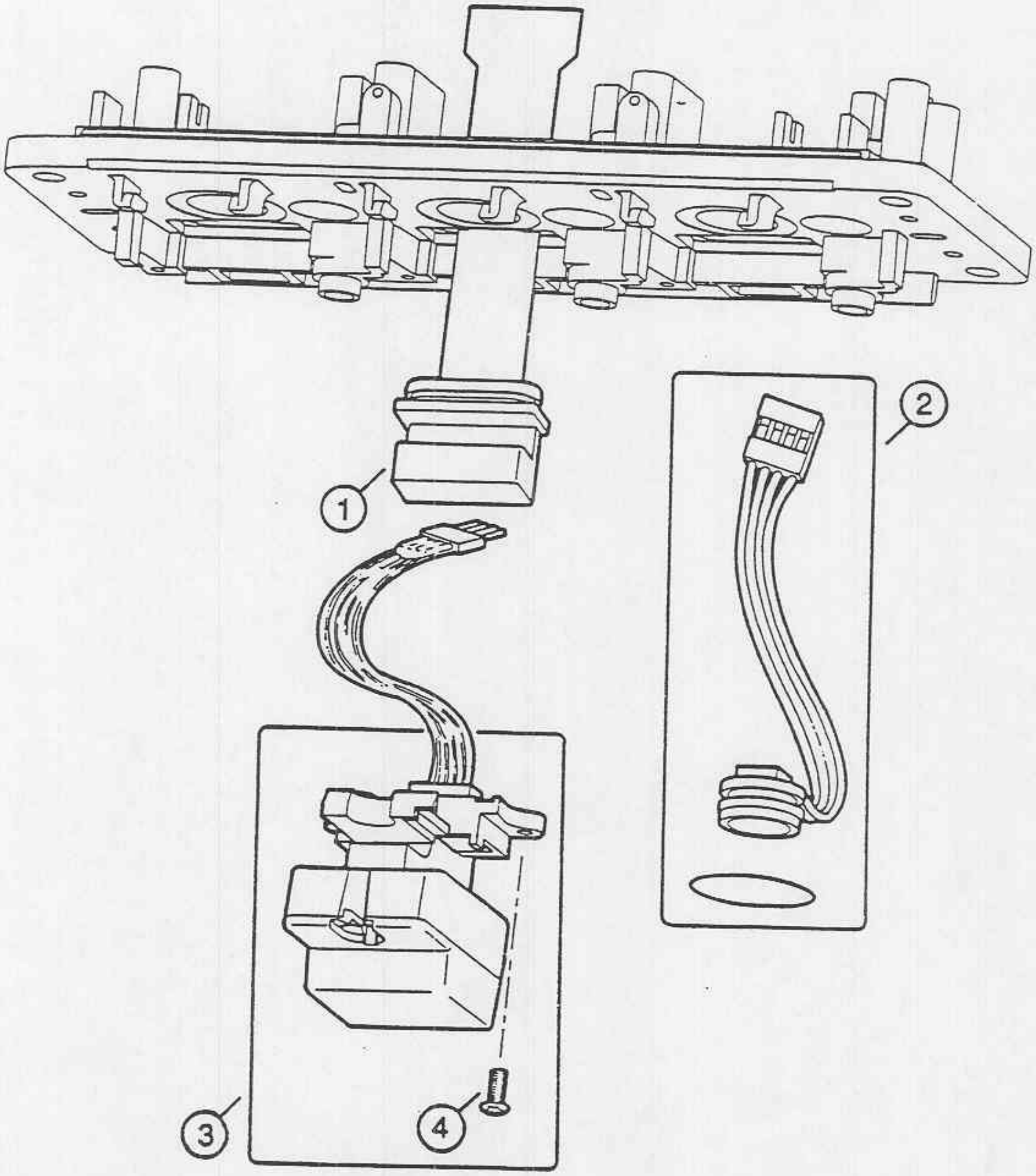

1
2
3
4
5
OPERATING INSTRUCTIONS
EXTERNAL POWER
A ECG
B ECG
COMM
C ECG PCA
6
7
8
9
10
12
13
14

SENSOR COMPONENTS

	Description	**Spare Part No.**	**Replacement No.**
1	Optomodule Assembly	2860851	
2	Pressure Transducer Kit	2860919	
3a	Air-in-line Sensor Kit (Model 2860)	2860802	
3b	Air-in-line Sensor Kit (Model 2863)	2860516	
4	Air-in-line Sensor Screws, 60/pkg.	2860950	

Note: The guide seal (Model 2860) and ultrasensor seal (Model 2860, 2863) are not shown in the accompanying illustration but are included in the applicable kit.

SENSOR COMPONENTS



NOTE: The Model 2863 Air-in-line sensor connector will appear differently.

F. List of Abbreviations and Acronyms

AAMI	Association for the Advancement of Medical Instrumentation
AC	alternating current
A/C	audio/connector
A/D	analog to digital
AILDOA	air-in-line detection output signal for Channel A
CLR	clear
CMOS	complimentary metal-oxide semiconductor
CRC	cyclical redundancy check
CSPWROFF	audio signal designation
DEL	signal indicating pumping cycle (delivery)
DEL*	complement of DEL
DC	direct current
DoD	Department of Defense
DOS	disk operating system
EL	electroluminescent
ELPWR*	output port designation
EPROM	erasable programmable read-only memory
ESD	electrostatic discharge
ETO	ethylene oxide
FET	field effect transistor
FMS	field maintenance software
FSO	fluid-side occlusion
FSOD	fluid-side occlusion detection
HOFF	debounced signal
IBM	International Business Machines Corp.
IC	integrated circuit
I.D.	identification
IEC	International Electrotechnical Commission
I/O	input/output
IRQ	interrupt request
IV	intraveneous
KBDDA	microprocessor interrupt designation
KBDINT*	microprocessor interrupt designation
KVO	keep vein open
LCD	liquid crystal display

LCDCTRST	output port control line designations
LCDCTRST2	output port control line designations
LCDCTRST3	output port control line designations
LED	light-emitting diode
LVL	level
mA	milliampere
mAh	milliampere hour
MEA	main electronics assembly
MHz	megahertz
µl	micro liter
ml	milliliter
ml/h	milliliter per hour
MOSPA	5V control
MOSNA	brake control
MRF	reset fault command using FMS
MRI	initialize parameters command using FMS
MOSFET	metal oxide semiconductor field effect transistor
MOTPWR*	output port designation; determines when +13V is asserted as output from power supply module
MOV	metal oxide varistor
ms	millisecond
NiCd	nickel cadmium
NFPA	National Fire Protection Agency
PCA	patient-controlled analgesia
PCB	printed circuit board
PCBA	printed circuit board assembly
PLD	programmable logic device
RAM	random access memory
RC	time constants determined by a Resistor/Capacitor combination
ROM	read only memory
RTC	real-time clock
SMT	surface mount technology
SW	software
TDC	top dead center
TOUT	timer output
UL	Underwriters Laboratory

V	volt
Vback	voltage of lithium backup battery
Vbb	voltage applied to circuits requiring backup battery power
Vcc	+5V supply
VCO	voltage-controlled oscillator
Vers.	version
Vext	external DC voltage produced by the AC adapter
Vlcd	LCD supply voltage
Vmot	motor voltage
VOL	volume
Vrms	AC voltage measured in root mean square
WCHAUD	watchdog audio tone signal

G. Glossary of Words and Terms

74C923	Keyboard decoder which debounces key presses, decodes the key matrix, and informs the microprocessor of a key press.
82C55	Integrated circuits used as input/output ports for microprocessor.
RS-232	Standard designation for serial communications cable between computers and other digital devices.
AC adapter	Converts line voltage into unregulated 9V DC power and provides electrical isolation for patient safety.
Advisory	A repeating series of double beeps which indicate conditions about which the operator should be aware, but which are not as critical as alarms.
Alarm	A repeating series of four beeps which indicate a condition that requires immediate attention.
DEL marker	A signal indicating pump delivery stroke.
Disposable	A single-use product for use in delivering fluid to the patient.
Fault	A repeating series of "European Police Siren" beeps which indicates that the software of the MedSystem III instrument has detected a malfunction that could lead to performance that is out of specification, uncontrolled, or potentially dangerous to the patient.
Fluid delivery	The transport and control of fluid from container to patient.
Fluid-side	Pertains to the fluid pathway between the container and the pump.
ICL7660	Integrated circuit designation.
Infusion	The administration or introduction of a fluid into a vein or artery.
Intravenous	Within a vein.
MAX236, etc.	Designation for an integrated circuit between the microprocessor CMOS LEVELS and RS-232 levels.
Occlusion	A condition in the fluid pathway that prevents flow.
Patient-side	Pertains to the fluid pathway between the pump and the patient.
SCI7661	Voltage tripler/regulator designation.
Subcutaneous	Below or under the skin.
Watchdog	A continuous audio tone which indicates software has not been executed properly by the microprocessor. This causes a fail-safe shutdown of the entire infusion device.

H. Safety Summary

Listed below are the meanings of **WARNING**, **CAUTION**, and **NOTE**, as used throughout this manual.

WARNING	A precaution that, if not followed, can result in personal or patient injury.
CAUTION	A precaution that, if not followed, can result in damage to equipment.
NOTE	Information that is of particular importance to the reader.

Warnings, cautions, and notes appear in the manual where applicable.

H.1 General Precautions

The following are general safety precautions that are not related to any specific procedure and, therefore, do not appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during many phases of operation, maintenance, and repair.

WARNING

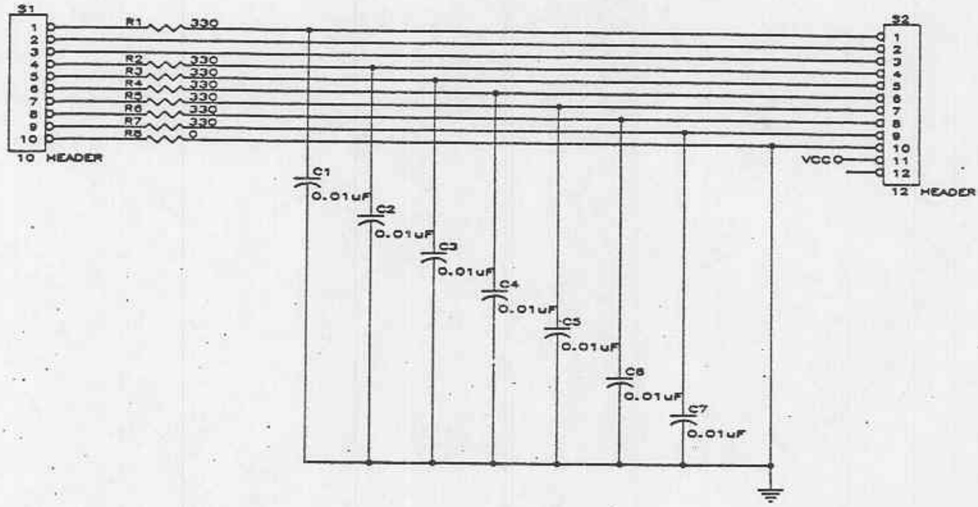
ISOPROPYL ALCOHOL IS FLAMMABLE AND MODERATELY TOXIC. AVOID CONTACT WITH THE EYES. DO NOT BREATHE VAPORS. EYE AND SKIN PROTECTION AND ADEQUATE VENTILATION ARE REQUIRED. IRRITATION TO THE EYES, SKIN, LUNGS, NOSE, AND THROAT MAY RESULT IF PERSONNEL FAIL TO OBSERVE THIS WARNING.

WARNING

ALWAYS MAKE CERTAIN THAT THE POWER TO THE INSTRUMENT IS OFF WHEN PERFORMING MAINTENANCE OR MAKING REPAIRS, UNLESS YOU HAVE BEEN ADVISED TO POWER-UP THE INSTRUMENT.

H.2 Specific Precautions

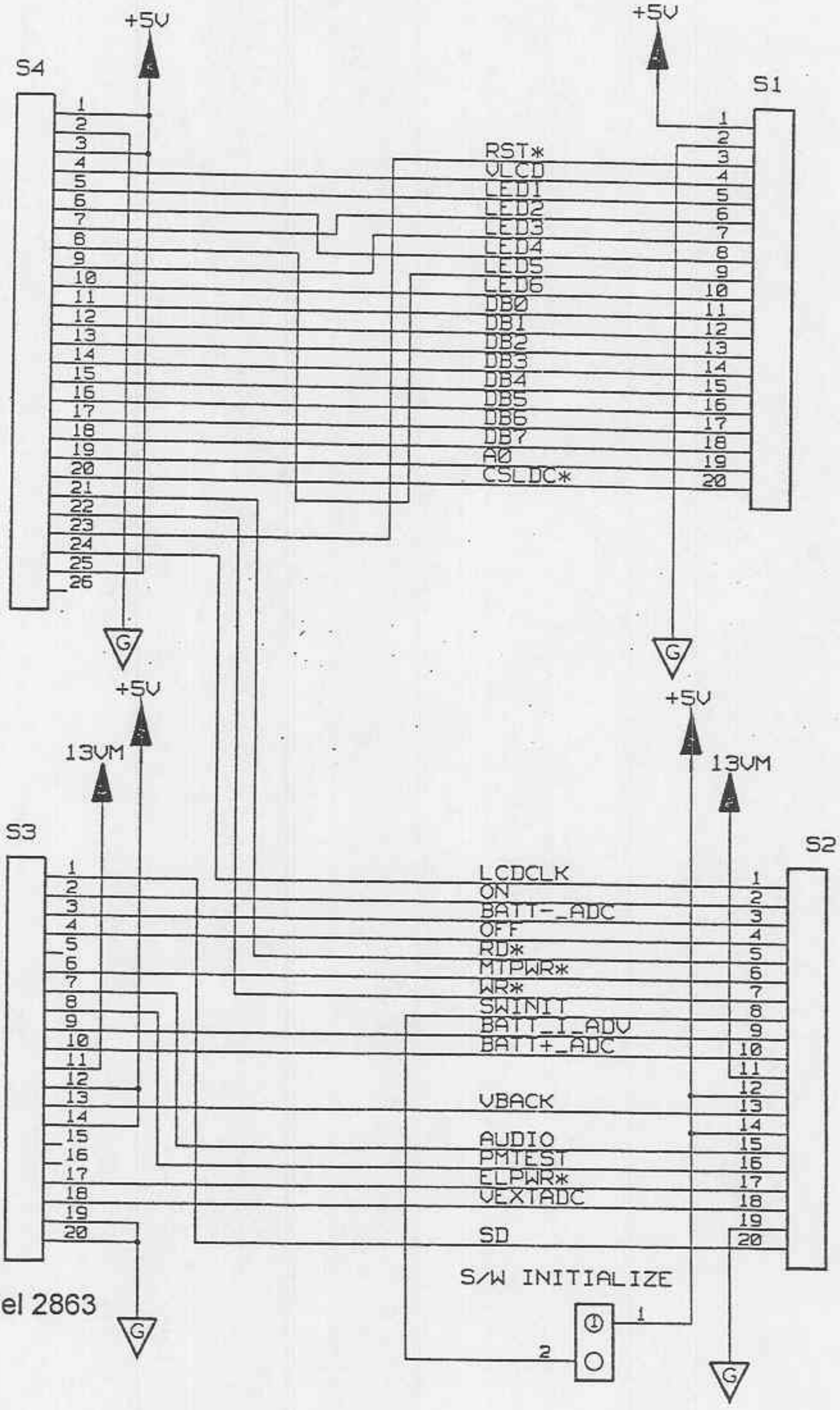
It is recommended that the user pay strict attention to the specific warnings and cautions given in each chapter of this manual.


S1
1
2
3
4
5
6
7
8
9
10
10 HEADER
R1 330
R2 330
R3 330
R4 330
R5 330
R6 330
R7 330
R8 0
C1 0.01uF
C2 0.01uF
C3 0.01uF
C4 0.01uF
C5 0.01uF
C6 0.01uF
C7 0.01uF
S2
1
2
3
4
5
6
7
8
9
10
11
12
VCC
12 HEADER

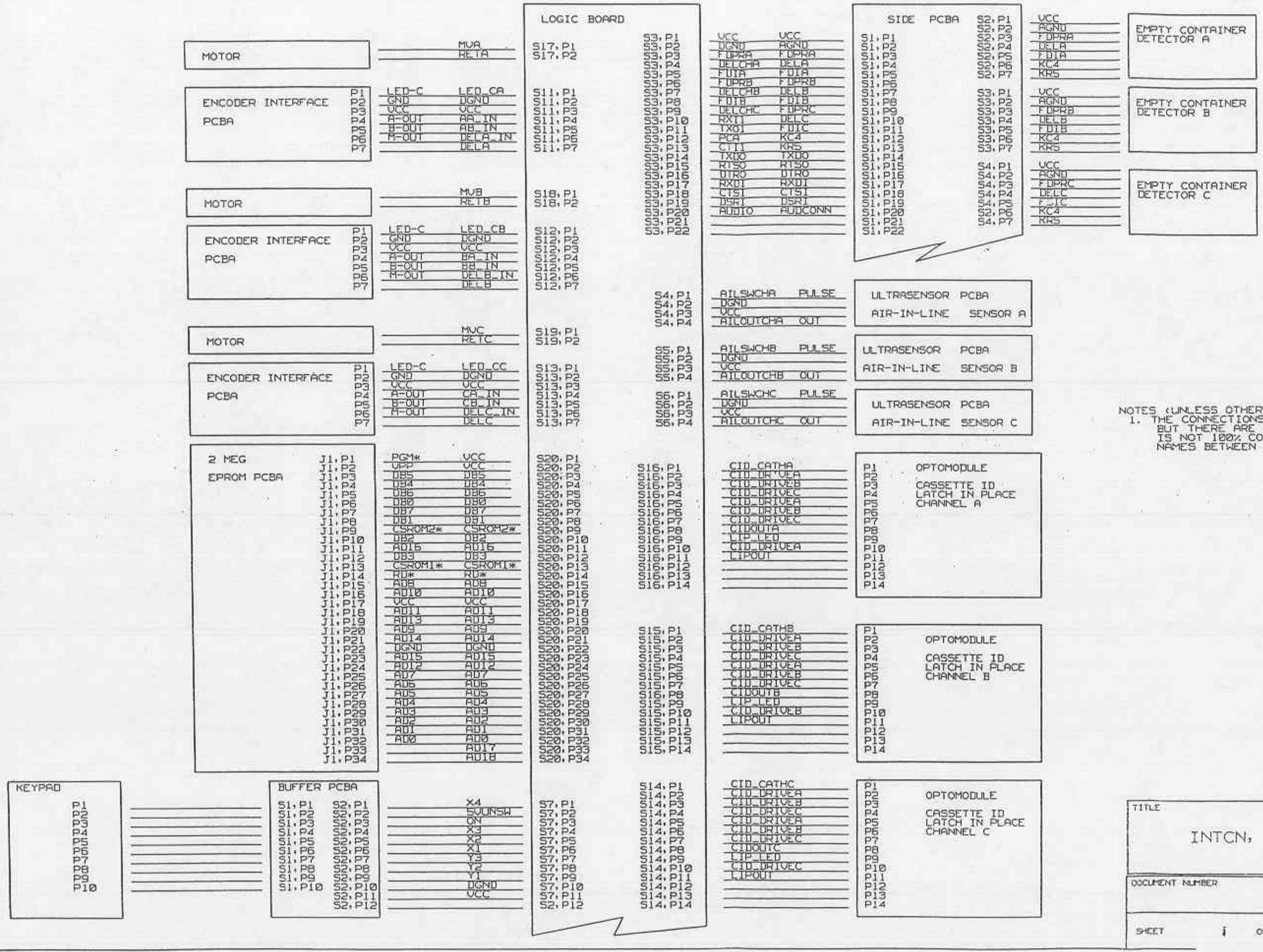
Model 2863 Buffer Board Schematic

NOTES (Unless otherwise specified):

1. Resistor values are in ohms, 1/4W, 5%, CF
2. Surface mount resistor values are in ohms, 1/8W, 1%, MF
3. Capacitors are 50V, Ceramic
4. Surface mount capacitors are 50V, Ceramic
5. Resistor network values are in ohms, 1/8W, 2%, CF

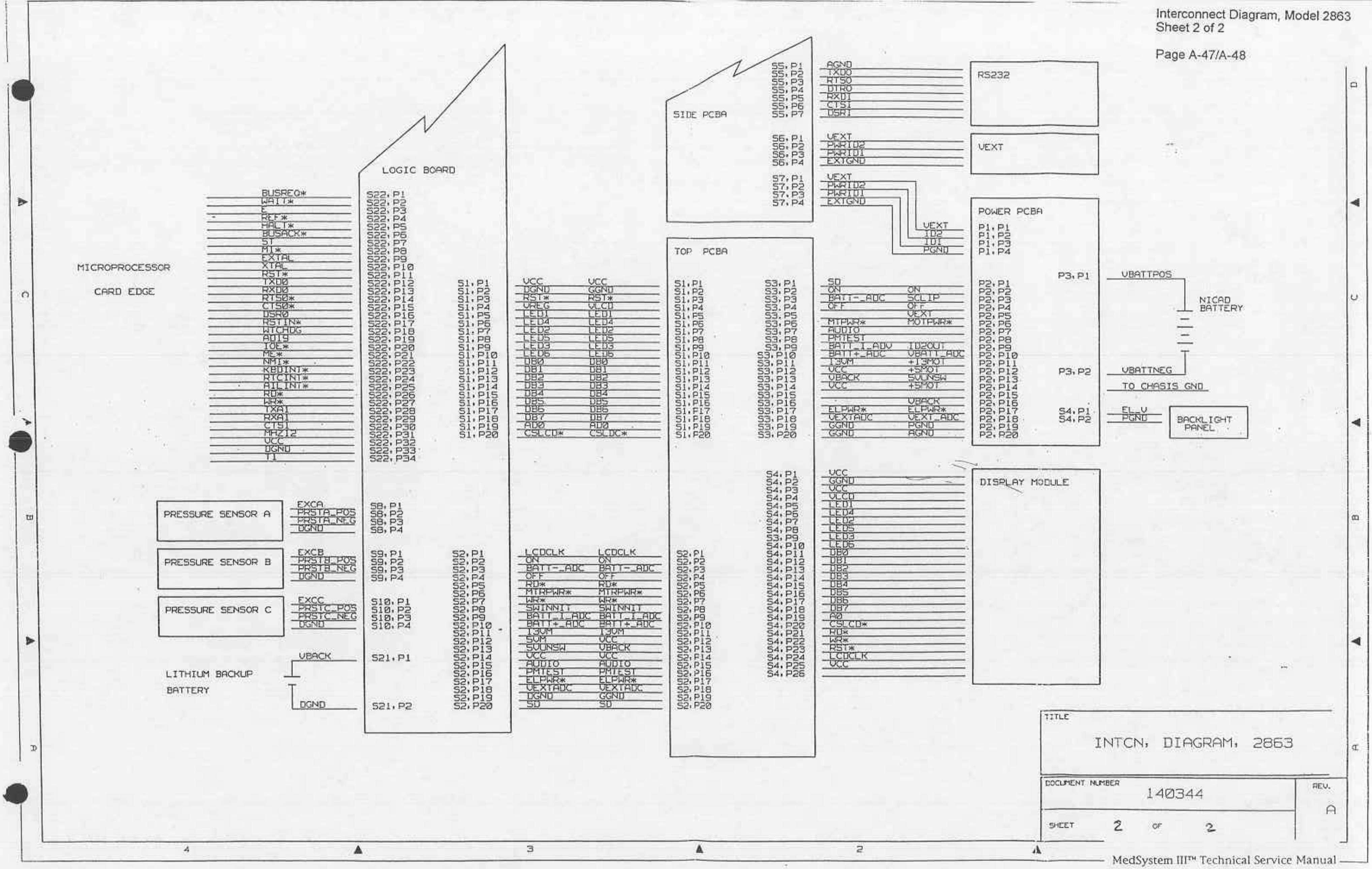

S4
S1
S3
S2
+5V
+5V
+5V
+5V
13VM
13VM
G
G
G
G
RST*
VLCD
LED1
LED2
LED3
LED4
LED5
LED6
DB0
DB1
DB2
DB3
DB4
DB5
DB6
DB7
A0
CSLDC*
LCDCLK
ON
BATT-_ADC
OFF
RD*
MTPWR*
WR*
SWINIT
BATT_I_ADV
BATT+_ADC
VBACK
AUDIO
PMTEST
ELPWR*
VEXTADC
SD
S/W INITIALIZE
1
2

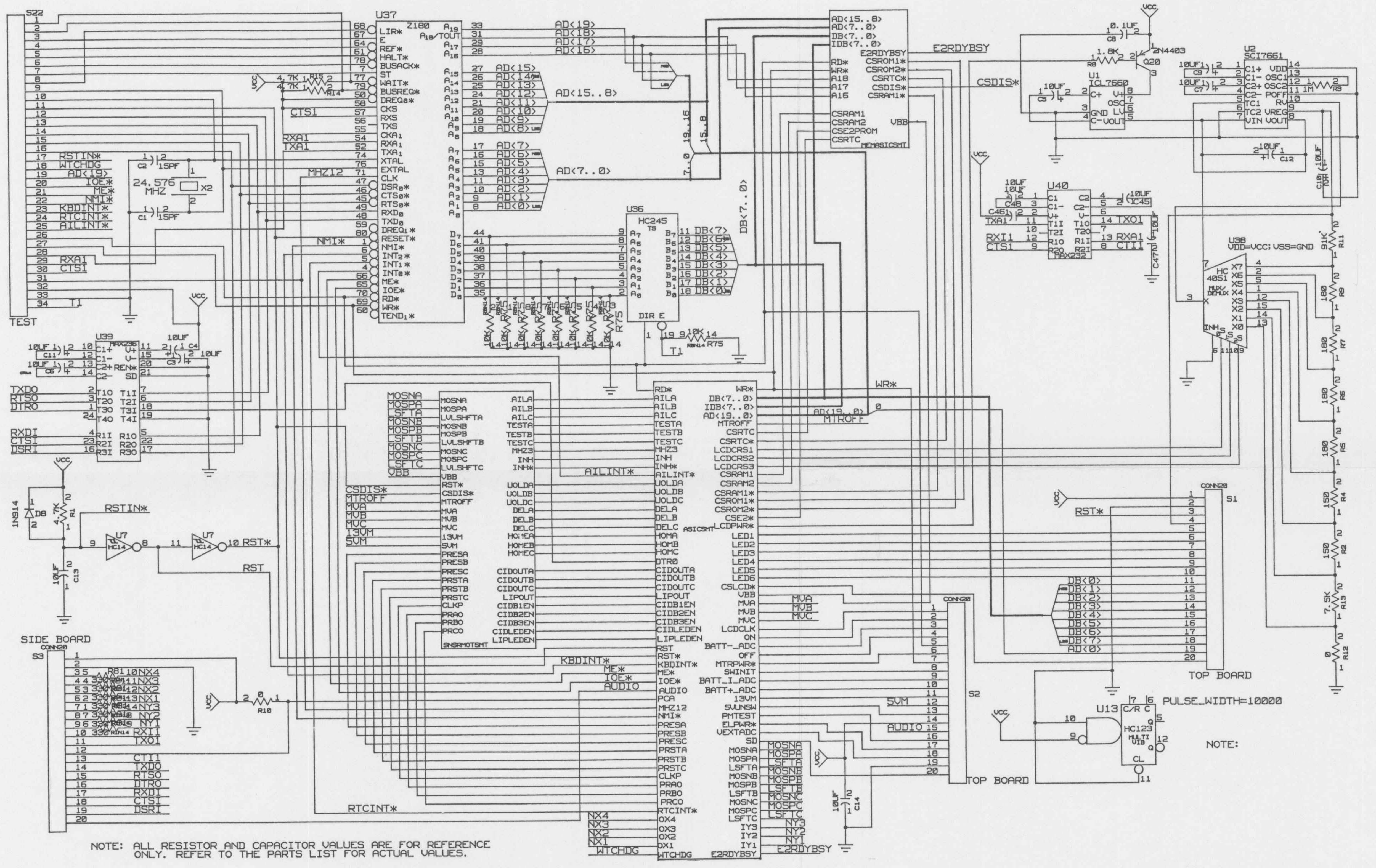
Top Board Schematic, Model 2863
Sheet 1 of 1


LOGIC BOARD
SIDE PCBA
MOTOR
MVA
RETA
S17,P1
S17,P2
ENCODER INTERFACE PCBA
LED-C GND VCC A-OUT B-OUT M-OUT
LED_CA DGND VCC AA_IN AB_IN DELA_IN DELA
S11,P1–S11,P7
MOTOR
MVB
RETB
S18,P1
S18,P2
ENCODER INTERFACE PCBA
LED_CB DGND VCC BA_IN BB_IN DELB_IN DELB
S12,P1–S12,P7
MOTOR
MVC
RETC
S19,P1
S19,P2
ENCODER INTERFACE PCBA
LED_CC DGND VCC CA_IN CB_IN DELC_IN DELC
S13,P1–S13,P7
2 MEG EPROM PCBA
J1,P1–J1,P34
PGM* VPP DB5 DB4 DB6 DB0 DB7 DB1 CSROM2* DB2 AD16 DB3 CSROM1* RD* AD8 AD10 VCC AD11 AD13 AD9 AD14 DGND AD15 AD12 AD7 AD6 AD5 AD4 AD3 AD2 AD1 AD0
VCC VCC DB5 DB4 DB6 DB0 DB7 DB1 CSROM2* DB2 AD16 DB3 CSROM1* RD* AD8 AD10 VCC AD11 AD13 AD9 AD14 DGND AD15 AD12 AD7 AD6 AD5 AD4 AD3 AD2 AD1 AD0 AD17 AD18
S20,P1–S20,P34
KEYPAD
P1–P10
BUFFER PCBA
S1,P1–S1,P10
S2,P1–S2,P12
X4 SVONSW ON X3 X2 X1 Y3 Y2 Y1 DGND VCC
S7,P1–S7,P10
S2,P11
S2,P12
S3,P1–S3,P22
VCC DGND FDPRA DELCHA FDIA FDPRB DELCHB FDIB DELCHC RXT1 TX01 PCA CTI1 TXDO RTSO DTRO RXDI CTSI DSRI AUDIO
VCC AGND FDPRA DELA FDIA FDPRB DELB FDIB FDPRC DELC FDIC KC4 KRS TXDO RTSO DTRO RXDI CTSI DSRI AUDCONN
S1,P1–S1,P22
S2,P1–S2,P7
S3,P1–S3,P7
S4,P1–S4,P7
VCC AGND FDPRA DELA FDIA KC4 KRS
VCC AGND FDPRB DELB FDIB KC4 KRS
VCC AGND FDPRC DELC FDIC KC4 KRS
EMPTY CONTAINER DETECTOR A
EMPTY CONTAINER DETECTOR B
EMPTY CONTAINER DETECTOR C
S4,P1–S4,P4
AILSWCHA PULSE DGND VCC AILOUTCHA OUT
ULTRASENSOR PCBA AIR-IN-LINE SENSOR A
S5,P1–S5,P4
AILSWCHB PULSE DGND VCC AILOUTCHB OUT
ULTRASENSOR PCBA AIR-IN-LINE SENSOR B
S6,P1–S6,P4
AILSWCHC PULSE DGND VCC AILOUTCHC OUT
ULTRASENSOR PCBA AIR-IN-LINE SENSOR C
S16,P1–S16,P14
CID_CATHA CID_DRIVEA CID_DRIVEB CID_DRIVEC CID_DRIVEA CID_DRIVEB CID_DRIVEC CIDOUTA LIP_LED CID_DRIVEA LIPOUT
P1–P14
OPTOMODULE CASSETTE ID LATCH IN PLACE CHANNEL A
S15,P1–S15,P14
CID_CATHB CID_DRIVEA CID_DRIVEB CID_DRIVEC CID_DRIVEA CID_DRIVEB CID_DRIVEC CIDOUTB LIP_LED CID_DRIVEB LIPOUT
P1–P14
OPTOMODULE CASSETTE ID LATCH IN PLACE CHANNEL B
S14,P1–S14,P14
CID_CATHC CID_DRIVEA CID_DRIVEB CID_DRIVEC CID_DRIVEA CID_DRIVEB CID_DRIVEC CIDOUTC LIP_LED CID_DRIVEC LIPOUT
P1–P14
OPTOMODULE CASSETTE ID LATCH IN PLACE CHANNEL C
4
3
2
A
B
C
D

NOTES (UNLESS OTHERWISE SPECIFIED):
1. THE CONNECTIONS ARE CORRECT AS SHOWN, BUT THERE ARE SOME CASES WHERE THERE IS NOT 100% CORRESPONDENCE IN SIGNAL NAMES BETWEEN BOARDS.

TITLE INTCN, DIAGRAM, 2863		
DOCUMENT NUMBER 140344		REV. A
SHEET 1 OF 2		


MICROPROCESSOR
CARD EDGE
BUSREQ*
WAIT*
E
REF*
HALT*
BUSACK*
ST
MI*
EXTAL
XTAL
RST*
TXD0
RXD0
RTS0*
CTS0*
DSR0
RSTIN*
WTCHDG
AD19
IOE*
ME*
NMI*
KBDINT*
RTCINT*
AILINT*
RD*
WR*
TXA1
RXA1
CTS1
MHZ12
VCC
DGND
T1
LOGIC BOARD
S22, P1
S22, P2
S22, P3
S22, P4
S22, P5
S22, P6
S22, P7
S22, P8
S22, P9
S22, P10
S22, P11
S22, P12
S22, P13
S22, P14
S22, P15
S22, P16
S22, P17
S22, P18
S22, P19
S22, P20
S22, P21
S22, P22
S22, P23
S22, P24
S22, P25
S22, P26
S22, P27
S22, P28
S22, P29
S22, P30
S22, P31
S22, P32
S22, P33
S22, P34
PRESSURE SENSOR A
EXCA
PRSTA_POS
PRSTA_NEG
DGND
S8, P1
S8, P2
S8, P3
S8, P4
PRESSURE SENSOR B
EXCB
PRSTB_POS
PRSTB_NEG
DGND
S9, P1
S9, P2
S9, P3
S9, P4
PRESSURE SENSOR C
EXCC
PRSTC_POS
PRSTC_NEG
DGND
S10, P1
S10, P2
S10, P3
S10, P4
LITHIUM BACKUP
BATTERY
VBACK
DGND
S21, P1
S21, P2
S1, P1
S1, P2
S1, P3
S1, P4
S1, P5
S1, P6
S1, P7
S1, P8
S1, P9
S1, P10
S1, P11
S1, P12
S1, P13
S1, P14
S1, P15
S1, P16
S1, P17
S1, P18
S1, P19
S1, P20
VCC VCC
DGND GGND
RST* RST*
VREG VLCD
LED1 LED1
LED4 LED4
LED2 LED2
LED5 LED5
LED3 LED3
LED6 LED6
DB0 DB0
DB1 DB1
DB2 DB2
DB3 DB3
DB4 DB4
DB5 DB5
DB6 DB6
DB7 DB7
AD0 AD0
CSLCD* CSLDC*
S2, P1
S2, P2
S2, P3
S2, P4
S2, P5
S2, P6
S2, P7
S2, P8
S2, P9
S2, P10
S2, P11
S2, P12
S2, P13
S2, P14
S2, P15
S2, P16
S2, P17
S2, P18
S2, P19
S2, P20
LCDCLK LCDCLK
ON ON
BATT-_ADC BATT-_ADC
OFF OFF
RD* RD*
MTRPWR* MTRPWR*
WR* WR*
SWINNIT SWINNIT
BATT_I_ADC BATT_I_ADC
BATT+_ADC BATT+_ADC
I3VM I3VM
SVM VCC
SVUNSW VBACK
VCC VCC
AUDIO AUDIO
PMTEST PMTEST
ELPWR* ELPWR*
VEXTADC VEXTADC
DGND GGND
SD SD
SIDE PCBA
S5, P1
S5, P2
S5, P3
S5, P4
S5, P5
S5, P6
S5, P7
S6, P1
S6, P2
S6, P3
S6, P4
S7, P1
S7, P2
S7, P3
S7, P4
TOP PCBA
S1, P1
S1, P2
S1, P3
S1, P4
S1, P5
S1, P6
S1, P7
S1, P8
S1, P9
S1, P10
S1, P11
S1, P12
S1, P13
S1, P14
S1, P15
S1, P16
S1, P17
S1, P18
S1, P19
S1, P20
S2, P1
S2, P2
S2, P3
S2, P4
S2, P5
S2, P6
S2, P7
S2, P8
S2, P9
S2, P10
S2, P11
S2, P12
S2, P13
S2, P14
S2, P15
S2, P16
S2, P17
S2, P18
S2, P19
S2, P20
S3, P1
S3, P2
S3, P3
S3. P4
S3. P5
S3, P6
S3, P7
S3, P8
S3, P9
S3, P10
S3, P11
S3, P12
S3, P13
S3, P14
S3, P15
S3, P16
S3, P17
S3, P18
S3, P19
S3, P20
S4, P1
S4, P2
S4, P3
S4, P4
S4, P5
S4, P6
S4, P7
S4, P8
S3, P9
S4, P10
S4, P11
S4, P12
S4, P13
S4, P14
S4, P15
S4, P16
S4, P17
S4, P18
S4, P19
S4, P20
S4, P21
S4, P22
S4, P23
S4, P24
S4, P25
S4, P26
AGND
TXD0
RTS0
DTR0
RXD1
CTS1
DSR1
VEXT
PWRID2
PWRID1
EXTGND
VEXT
PWRID2
PWRID1
EXTGND
VEXT
ID2
ID1
PGND
SD
ON ON
BATT-_ADC SCLIP
OFF OFF
VEXT
MTPWR* MOTPWR*
AUDIO
PMTEST
BATT_I_ADV ID2OUT
BATT+_ADC VBATT_ADC
I3VM +I3MOT
VCC +5MOT
VBACK 5VUNSW
VCC +5MOT
VBACK
ELPWR* ELPWR*
VEXTADC VEXT_ADC
GGND PGND
GGND AGND
VCC
GGND
VCC
VLCD
LED1
LED4
LED2
LED5
LED3
LED6
DB0
DB1
DB2
DB3
DB4
DB5
DB6
DB7
A0
CSLCD*
RD*
WR*
RST*
LCDCLK
VCC
RS232
VEXT
POWER PCBA
P1, P1
P1, P2
P1, P3
P1. P4
P2, P1
P2, P2
P2, P3
P2, P4
P2, P5
P2, P6
P2, P7
P2, P8
P2, P9
P2, P10
P2, P11
P2, P12
P2, P13
P2, P14
P2, P15
P2, P16
P2, P17
P2, P18
P2, P19
P2, P20
P3, P1
P3, P2
S4, P1
S4, P2
DISPLAY MODULE
VBATTPOS
NICAD
BATTERY
VBATTNEG
TO CHASIS GND
EL_V
PGND
BACKLIGHT
PANEL
TITLE
INTCN, DIAGRAM, 2863
DOCUMENT NUMBER
140344
REV.
A
SHEET
2
OF
2
D
C
B
A
4
3
2


8
7
6
5
4
3
2
1
D
C
B
A
S22
TEST
U37
Z180
U36
HC245
U39
U40
U1
ICL7660
U2
SCI7661
Q20
2N4403
U38
VDD=VCC VSS=GND
U13
HC123
X2
24.576 MHZ
AD<15..8>
AD<7..0>
DB<7..0>
E2RDYBSY
CSDIS*
RSTIN*
RST*
RST
AILINT*
KBDINT*
RTCINT*
WR*
MTROFF
SIDE BOARD
S3
CONN20
S2
TOP BOARD
S1
TOP BOARD
PULSE_WIDTH=10000
NOTE:

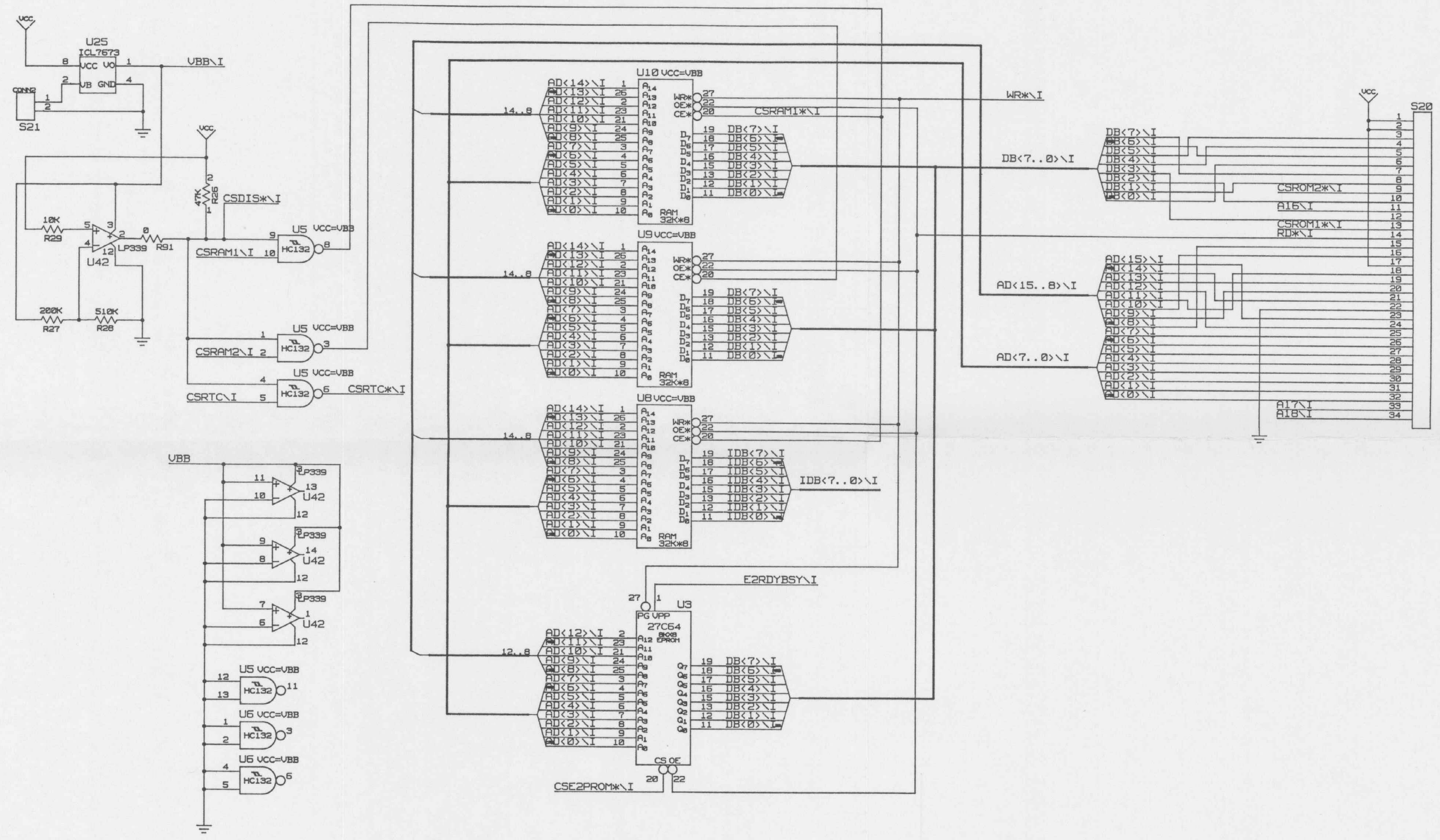
NOTE: ALL RESISTOR AND CAPACITOR VALUES ARE FOR REFERENCE ONLY. REFER TO THE PARTS LIST FOR ACTUAL VALUES.

MAIN ELECTRONICS ASSEMBLY
MODEL 2863
SHEET 1 OF 4

NOTES: UNLESS OTHERWISE SPECIFIED.

D9195287-003 REV-

ARBCO GRAPHIC ARTS CENTER 154820


VCC
U25
ICL7673
VCC VO
VB GND
VBB\I
CONN2
S21
10K
R29
U42
LP339
0
R91
47K
R26
CSDIS*\I
U5 VCC=VBB
HC132
CSRAM1\I
CSRAM2\I
CSRTC\I
CSRTC*\I
200K
R27
510K
R28
VBB
U6 VCC=VBB
U10 VCC=VBB
RAM
32K*8
U9 VCC=VBB
U8 VCC=VBB
AD<14>\I
AD<0>\I
14..0
12..0
WR*
OE*
CE*
DB<7>\I
DB<0>\I
IDB<7>\I
IDB<0>\I
IDB<7..0>\I
CSRAM1*\I
WR*\I
DB<7..0>\I
AD<15..8>\I
AD<7..0>\I
E2RDYBSY\I
U3
27C64
8KX8 EPROM
PG VPP
CS OE
CSE2PROM*\I
S20
CSROM2*\I
A16\I
CSROM1*\I
RD*\I
AD<15>\I
A17\I
A18\I

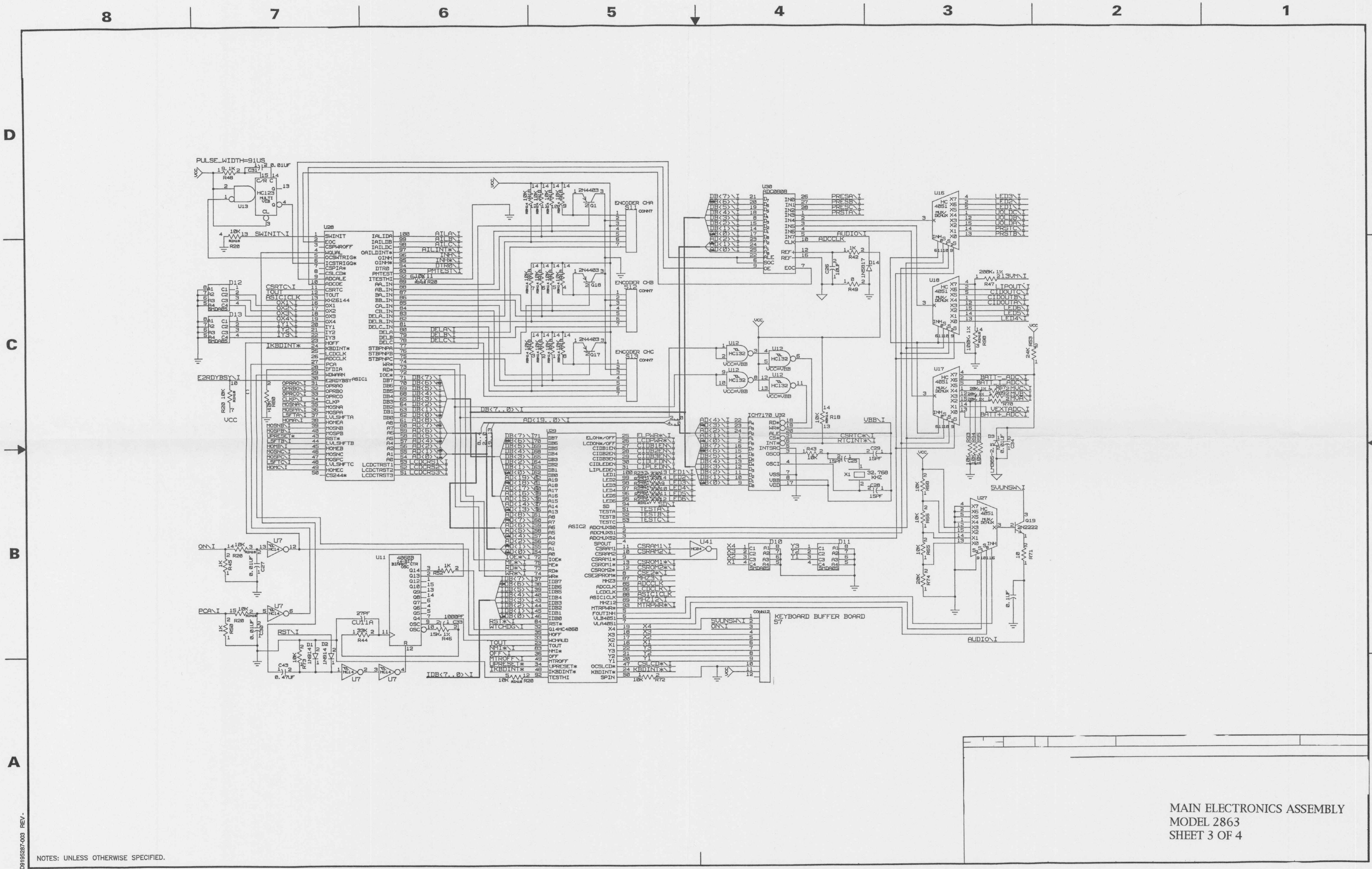
NOTES: UNLESS OTHERWISE SPECIFIED.

MAIN ELECTRONICS ASSEMBLY
MODEL 2863
SHEET 2 OF 4

D9195287-003 REV -

ARBCO GRAPHIC ARTS CENTER 154820

alaris 2


8
7
6
5
4
3
2
1
D
C
B
A
PULSE_WIDTH=91US
U13
HC123
SWINIT\I
U28
ASIC1
ENCODER CHA
S11
ENCODER CHB
S12
ENCODER CHC
S13
2N4403
Q1
Q18
Q17
U30
ADC0808
ICM7170 U32
X1 32.768 KHZ
U12
HC132
VCC=VBB
U16
U18
U17
HC 4051 MUX/DEMUX
LED3\I
LED2\I
LED1\I
PRSTC\I
PRSTB\I
U29
ASIC2
D12
D13
D10
D11
U11
4060B
U7
U41
CU11A
U27
Q19
2N2222
KEYBOARD BUFFER BOARD
S7
DB<7..0>\I
AD<19..0>\I
IDB<7..0>\I
ON\I
PCA\I
RST\I
E2RDYBSY\I
SVUNSW\I
AUDIO\I
VBB\I
VCC

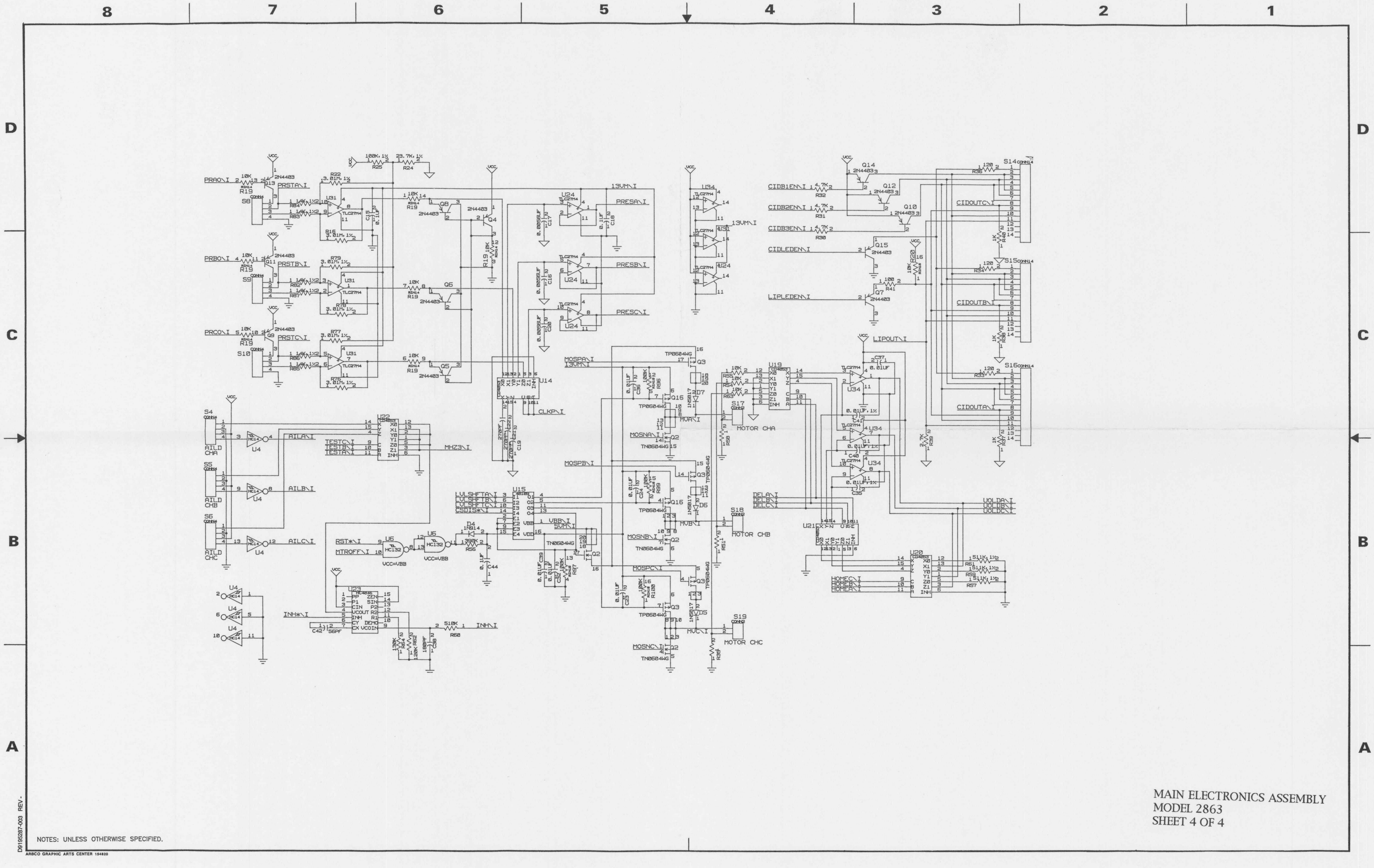
MAIN ELECTRONICS ASSEMBLY
MODEL 2863
SHEET 3 OF 4

NOTES: UNLESS OTHERWISE SPECIFIED.

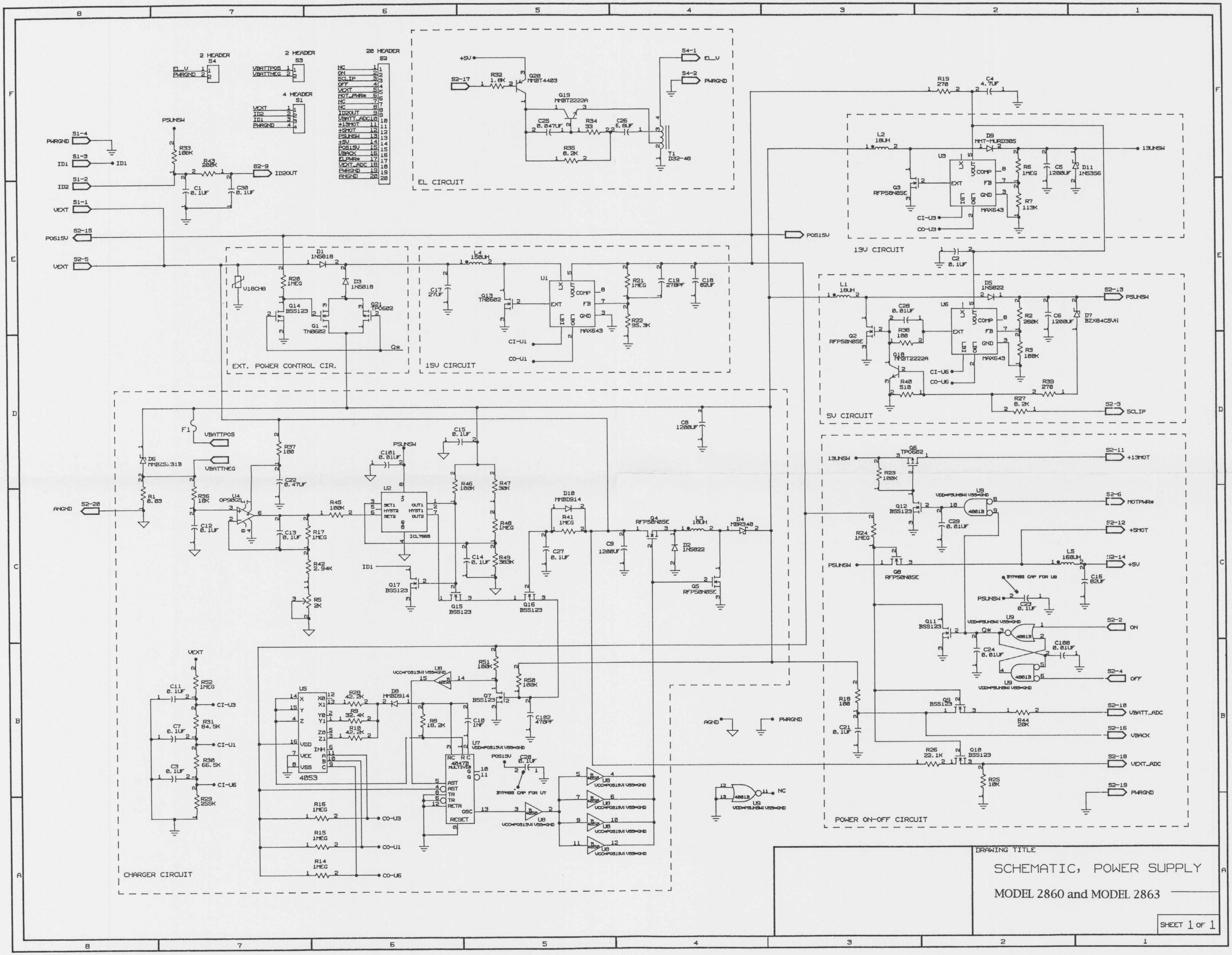
D9195287-003 REV-

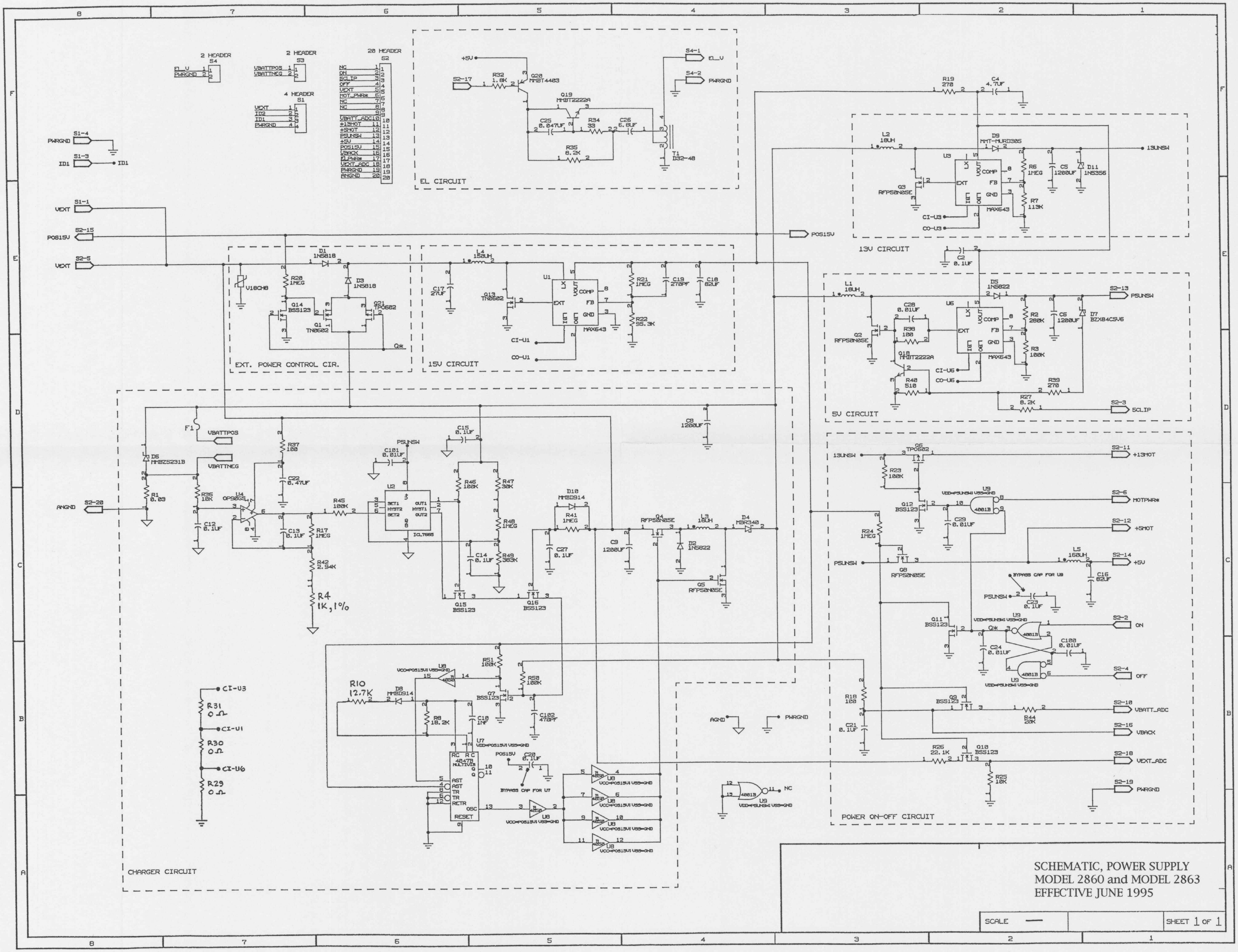
ARBCO GRAPHIC ARTS CENTER 154820

alaris 3


8
7
6
5
4
3
2
1
D
C
B
A
PRA0\I
PRB0\I
PRC0\I
PRSTA\I
PRSTB\I
PRSTC\I
S8
S9
S10
2N4403
TLC27M4
U31
U24
U34
PRESA\I
PRESB\I
PRESC\I
13VM\I
CLKP\I
U14
S4
S5
S6
AILD CHA
AILD CHB
AILD CHC
AILA\I
AILB\I
AILC\I
U4
U22
TESTC\I
TESTB\I
TESTA\I
MHZ3\I
LVLSHFTA\I
LVLSHFTB\I
LVLSHFTC\I
CSDIS*\I
U15
VBB\I
SUM\I
RST*\I
MTROFF\I
U6
MC132
VCC=VBB
D4
1N914
U23
INH*\I
MOSPA\I
MOSNA\I
MOSPB\I
MOSNB\I
MOSPC\I
MOSNC\I
TP0604WG
TN0604WG
1N5817
MVA\I
MVB\I
MVC\I
S17
S18
S19
MOTOR CHA
MOTOR CHB
MOTOR CHC
U19
U20
U21
DELA\I
DELB\I
DELC\I
VOLDA\I
VOLDB\I
VOLDC\I
HOMEC\I
HOMEB\I
HOMEA\I
CIDB1EN\I
CIDB2EN\I
CIDB3EN\I
CIDLEDEN\I
LIPLEDEN\I
LIPOUT\I
CIDOUTC\I
CIDOUTB\I
CIDOUTA\I
Q14
Q12
Q10
Q15
Q7
S14
S15
S16
CONN14
VCC
NOTES: UNLESS OTHERWISE SPECIFIED.
D9195287-003 REV -
ARBCO GRAPHIC ARTS CENTER 154820

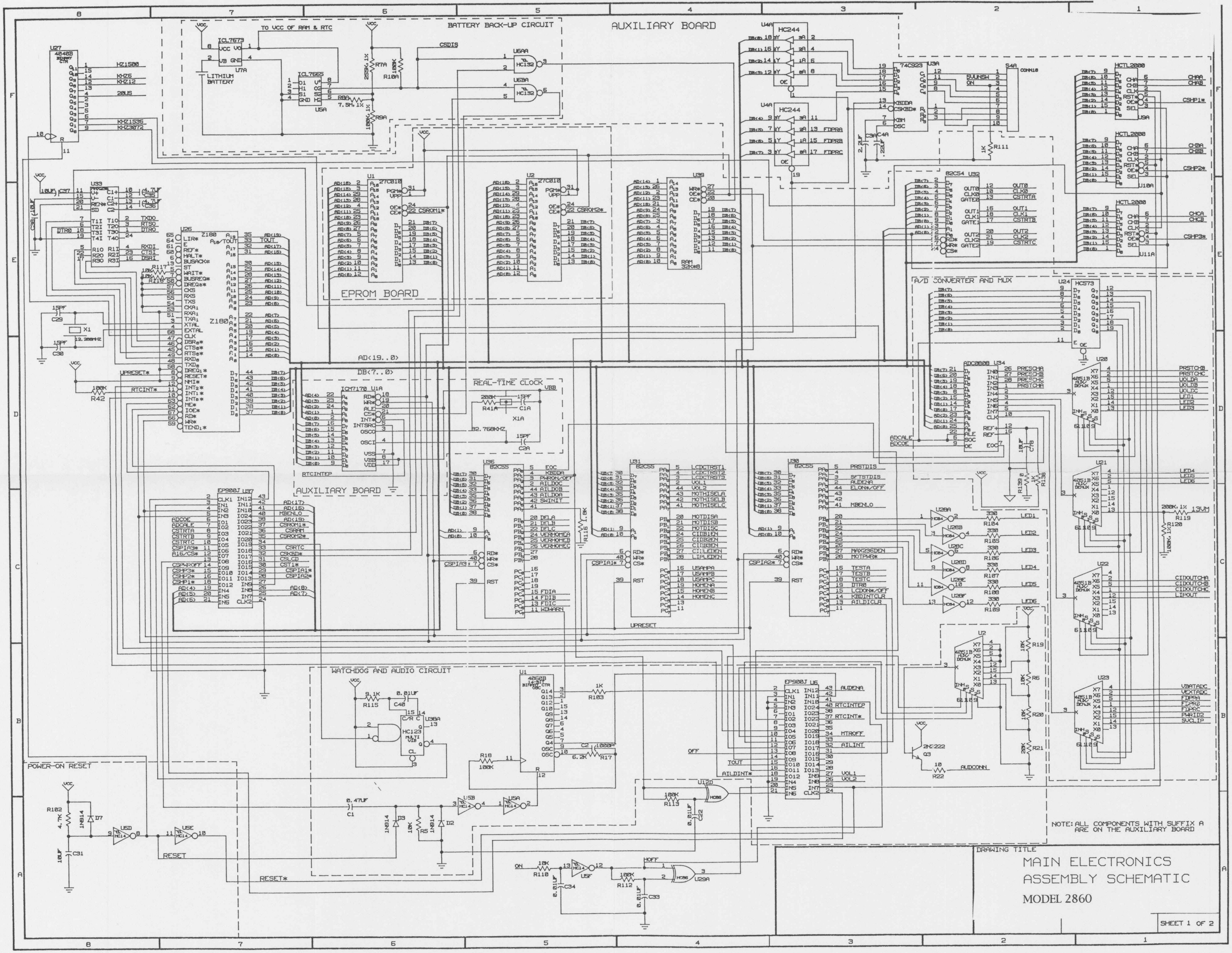
MAIN ELECTRONICS ASSEMBLY
MODEL 2863
SHEET 4 OF 4

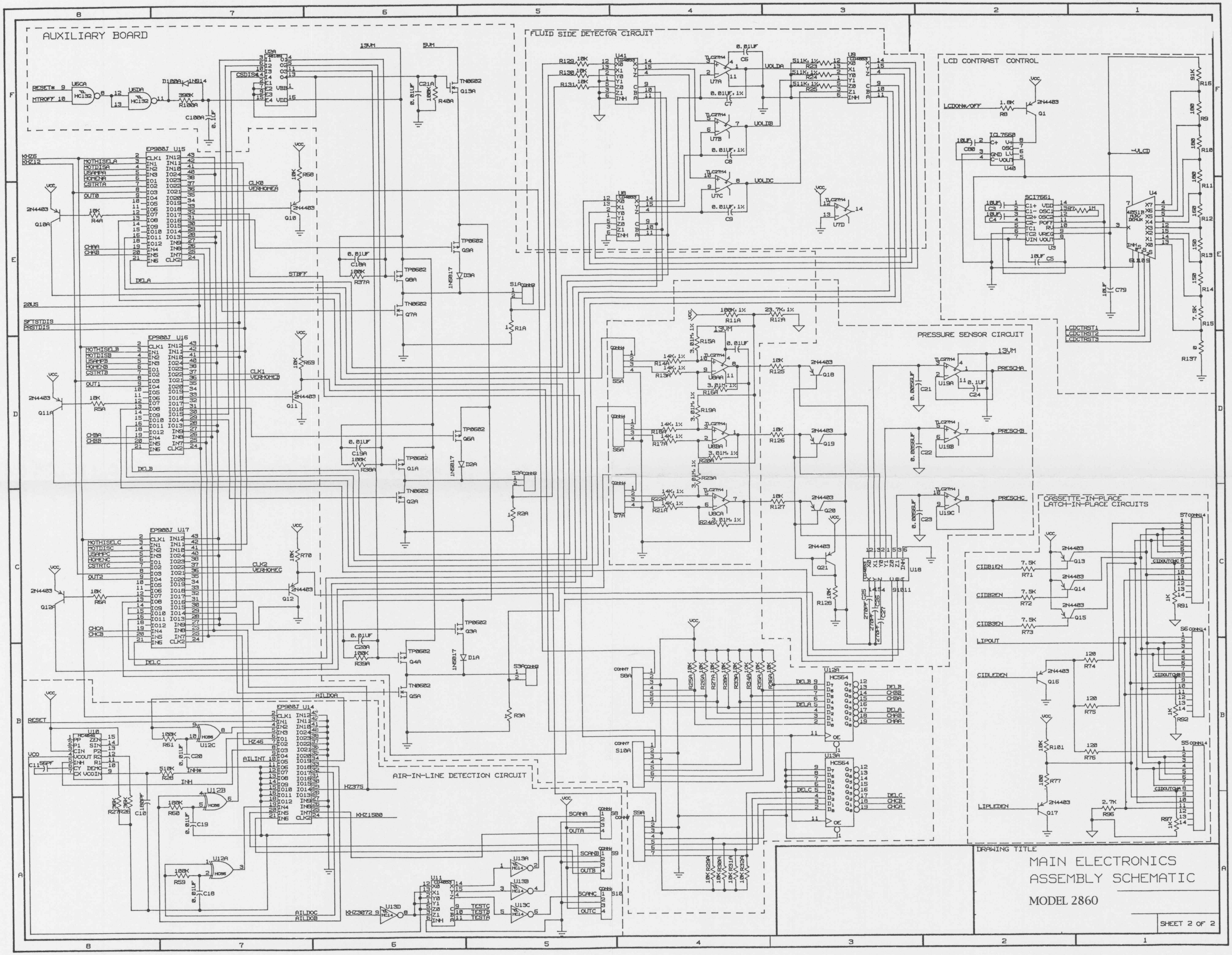

EL CIRCUIT
EXT. POWER CONTROL CIR.
15V CIRCUIT
13V CIRCUIT
5V CIRCUIT
CHARGER CIRCUIT
POWER ON-OFF CIRCUIT
2 HEADER S4
2 HEADER S3
4 HEADER S1
20 HEADER S2
EL_V
PWRGND
VBATTPOS
VBATTNEG
VEXT
ID2
ID1
NC
ON
SCLIP
OFF
MOT_PWR*
ID2OUT
VBATT_ADC
+13MOT
+5MOT
PSUNSW
+5V
POS15V
VBACK
ELPWR*
VEXT_ADC
ANGND
S1-4
S1-3
S1-2
S1-1
S2-15
S2-5
S2-9
S2-17
S2-20
S2-13
S2-3
S2-11
S2-6
S2-12
S2-14
S2-2
S2-4
S2-10
S2-16
S2-18
S2-19
S4-1
S4-2
R33 100K
R43 200K
C1 0.1UF
C30 0.1UF
R32 1.8K
Q20 MMBT4403
Q19 MMBT2222A
C25 0.047UF
R34 33
C26 6.8UF
R35 8.2K
T1 D32-48
R19 270
C4 4.7UF
L2 18UH
D9 MMT-MURD305
U3
MAX643
Q3 RFP50N05E
R6 1MEG
C5 1200UF
D11 1N5356
R7 113K
CI-U3
CO-U3
13UNSW
C2 0.1UF
D1 1N5818
D3 1N5818
R20 1MEG
V18CH8
Q14 BSS123
Q21 TP0602
Q1 TN0602
Q*
L4 150UH
C17 27UF
Q13 TN0602
U1
MAX643
R21 1MEG
C19 270PF
C18 82UF
R22 55.3K
CI-U1
CO-U1
L1 18UH
D5 1N5822
C28 0.01UF
R36 100
U6
MAX643
Q2 RFP50N05E
Q18 MMBT2222A
R40 510
R2 200K
C6 1200UF
D7 BZX84C5V6
R3 100K
R39 270
R27 8.2K
CI-U6
CO-U6
F1
D6 MMBZ5.31B
R1 0.03
R36 10K
C12 0.1UF
U4 OP90GS
R37 100
C22 0.47UF
C13 0.1UF
R17 1MEG
R42 2.94K
R5 2K
R45 100K
C101 0.01UF
U2 ICL7665
C15 0.1UF
R46 100K
R47 30K
R48 1MEG
R49 383K
C14 0.1UF
Q17 BSS123
Q15 BSS123
Q16 BSS123
D10 MMBD914
R41 1MEG
C27 0.1UF
C9 1200UF
Q4 RFP50N05E
L3 18UH
D4 MBR340
D2 1N5822
Q5 RFP50N05E
C8 1200UF
C11 0.1UF
R52 1MEG
R31 84.5K
C7 0.1UF
R30 66.5K
C3 0.1UF
R29 255K
CI-U3
CI-U1
CI-U6
U5 4053
R28 42.2K
R9 32.4K
R10 42.2K
D8 MMBD914
R8 18.2K
C10 1NF
U7 4047B MULTIVIB
C20 0.1UF
BYPASS CAP FOR U7
R51 100K
R50 100K
Q7 BSS123
C102 470PF
U8 4050
VCC=POS15V VSS=GND
R16 1MEG
R15 1MEG
R14 1MEG
CO-U3
CO-U1
CO-U6
AGND
PWRGND
U9 4001B
VDD=PSUNSW VSS=GND
Q6 TP0602
R23 100K
Q12 BSS123
C29 0.01UF
R24 1MEG
Q8 RFP50N05E
L5 160UH
C16 82UF
BYPASS CAP FOR U9
C23 0.1UF
Q11 BSS123
C24 0.01UF
C100 0.01UF
R18 100
C21 0.1UF
Q9 BSS123
R44 20K
R26 22.1K
Q10 BSS123
R25 10K
DRAWING TITLE
SCHEMATIC, POWER SUPPLY
MODEL 2860 and MODEL 2863
SHEET 1 OF 1

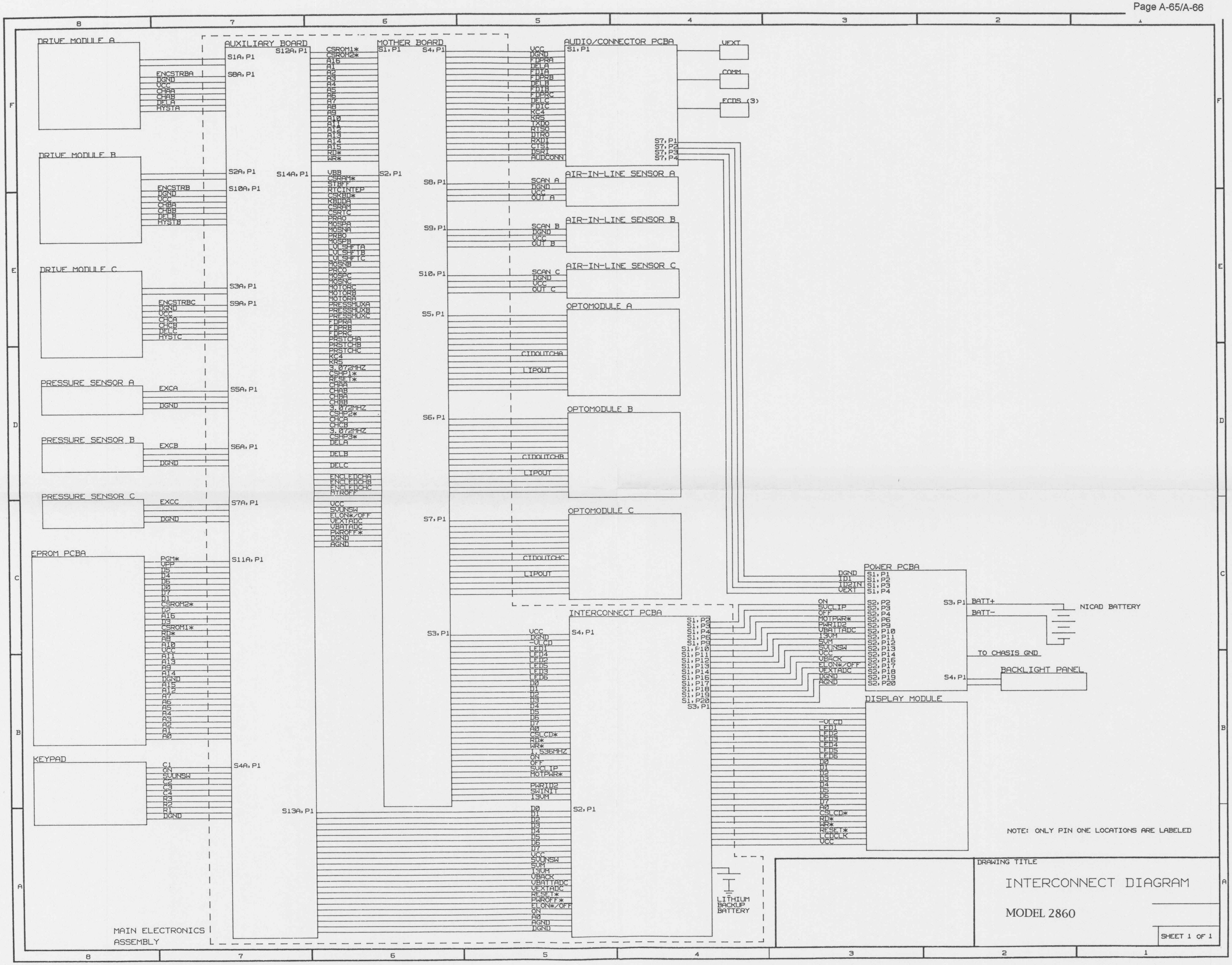

8
7
6
5
4
3
2
1
F
E
D
C
B
A
2 HEADER
S4
EL_V
PWRGND
2 HEADER
S3
VBATTPOS
VBATTNEG
4 HEADER
S1
VEXT
ID2
ID1
PWRGND
20 HEADER
S2
NC
ON
SCLIP
OFF
VEXT
MOT_PWR*
NC
NC
VBATT_ADC
+13MOT
+5MOT
PSUNSW
+5V
POS15V
VBACK
ELPWR*
VEXT_ADC
PWRGND
ANGND
S1-4
PWRGND
S1-3
ID1
S1-1
VEXT
S2-15
POS15V
S2-5
VEXT
+5V
S2-17
R32
1.8K
Q20
MMBT4403
Q19
MMBT2222A
C25
0.047UF
R34
33
C26
6.8UF
R35
8.2K
T1
D32-48
S4-1
EL_V
S4-2
PWRGND
EL CIRCUIT
R19
270
C4
4.7UF
L2
18UH
D9
MMT-MURD30S
U3
R6
1MEG
C5
1200UF
D11
1N5356
13UNSW
Q3
RFP50N05E
R7
113K
MAX643
CI-U3
CO-U3
13V CIRCUIT
POS15V
C2
0.1UF
D1
1N5818
D3
1N5818
R20
1MEG
V18CH8
Q14
BSS123
Q21
TP0602
Q1
TN0602
Q*
EXT. POWER CONTROL CIR.
L4
150UH
C17
27UF
Q13
TN0602
U1
R21
1MEG
C19
270PF
C18
82UF
R22
55.3K
MAX643
CI-U1
CO-U1
15V CIRCUIT
L1
18UH
D5
1N5822
S2-13
PSUNSW
C28
0.01UF
U6
R2
200K
C6
1200UF
D7
BZX84C5V6
Q2
RFP50N05E
R38
100
Q18
MMBT2222A
R3
100K
MAX643
R40
510
CI-U6
CO-U6
R39
270
R27
8.2K
S2-3
SCLIP
5V CIRCUIT
F1
VBATTPOS
VBATTNEG
D6
MMBZ5231B
R1
0.03
S2-20
ANGND
R36
10K
U4
OP90GS
C12
0.1UF
R37
100
C22
0.47UF
C13
0.1UF
R17
1MEG
R42
2.94K
R4
1K,1%
R45
100K
PSUNSW
C101
0.01UF
U2
SET1
HYST2
SET2
OUT1
HYST1
OUT2
ICL7665
C15
0.1UF
R46
100K
R47
30K
R48
1MEG
C14
0.1UF
R49
383K
Q15
BSS123
Q16
BSS123
D10
MMBD914
R41
1MEG
C27
0.1UF
C9
1200UF
C8
1200UF
Q4
RFP50N05E
L3
18UH
D4
MBR340
D2
1N5822
Q5
RFP50N05E
R51
100K
R50
100K
Q7
BSS123
C102
470PF
R10
12.7K
D8
MMBD914
R8
18.2K
C10
1NF
U8
VCC=POS15V VSS=GND
U7
VDD=POS15V VSS=GND
4047B
MULTIVIB
RC
AST
TR
RETR
OSC
RESET
POS15V
C20
0.1UF
BYPASS CAP FOR U7
CI-U3
R31
0Ω
CI-U1
R30
0Ω
CI-U6
R29
0Ω
CHARGER CIRCUIT
AGND
PWRGND
4001B
U9
VDD=PSUNSW VSS=GND
NC
13UNSW
Q6
TP0602
R23
100K
S2-11
+13MOT
Q12
BSS123
U9
VDD=PSUNSW VSS=GND
4001B
C29
0.01UF
S2-6
MOTPWR*
R24
1MEG
S2-12
+5MOT
PSUNSW
Q8
RFP50N05E
L5
150UH
S2-14
+5V
C16
82UF
BYPASS CAP FOR U9
PSUNSW
C23
0.1UF
Q11
BSS123
Q*
C24
0.01UF
C100
0.01UF
S2-2
ON
S2-4
OFF
R18
100
C21
0.1UF
Q9
BSS123
R44
20K
S2-10
VBATT_ADC
S2-16
VBACK
R26
22.1K
Q10
BSS123
R25
10K
S2-18
VEXT_ADC
S2-19
PWRGND
POWER ON-OFF CIRCUIT
SCALE
SHEET 1 OF 1

SCHEMATIC, POWER SUPPLY
MODEL 2860 and MODEL 2863
EFFECTIVE JUNE 1995

alaris


AUXILIARY BOARD
BATTERY BACK-UP CIRCUIT
TO VCC OF RAM & RTC
LITHIUM BATTERY
ICL7673
ICL7665
CSDIS
EPROM BOARD
27C010
RAM 32K*8
Z180
REAL-TIME CLOCK
ICM7170
32.768KHZ
12.288MHZ
AD<19..0>
DB<7..0>
RTCINTEP
EP900J
82C55
82C54
74C923
HC244
HCTL2000
A/D CONVERTER AND MUX
HC573
ADC0808
4051B
WATCHDOG AND AUDIO CIRCUIT
4060B
HC123
POWER-ON RESET
RESET
RESET*
UPRESET
AUDCONN
NOTE: ALL COMPONENTS WITH SUFFIX A ARE ON THE AUXILIARY BOARD
DRAWING TITLE
MAIN ELECTRONICS ASSEMBLY SCHEMATIC
MODEL 2860
SHEET 1 OF 2


AUXILIARY BOARD
FLUID SIDE DETECTOR CIRCUIT
LCD CONTRAST CONTROL
PRESSURE SENSOR CIRCUIT
CASSETTE-IN-PLACE
LATCH-IN-PLACE CIRCUITS
AIR-IN-LINE DETECTION CIRCUIT
DRAWING TITLE
MAIN ELECTRONICS
ASSEMBLY SCHEMATIC
MODEL 2860
SHEET 2 OF 2
8
7
6
5
4
3
2
1
A
B
C
D
E
F


DRIVE MODULE A
DRIVE MODULE B
DRIVE MODULE C
PRESSURE SENSOR A
PRESSURE SENSOR B
PRESSURE SENSOR C
EPROM PCBA
KEYPAD
AUXILIARY BOARD
MOTHER BOARD
AUDIO/CONNECTOR PCBA
VEXT
COMM
FCDS (3)
AIR-IN-LINE SENSOR A
AIR-IN-LINE SENSOR B
AIR-IN-LINE SENSOR C
OPTOMODULE A
OPTOMODULE B
OPTOMODULE C
INTERCONNECT PCBA
POWER PCBA
NICAD BATTERY
BATT+
BATT-
TO CHASIS GND
BACKLIGHT PANEL
DISPLAY MODULE
LITHIUM BACKUP BATTERY
MAIN ELECTRONICS ASSEMBLY
NOTE: ONLY PIN ONE LOCATIONS ARE LABELED
DRAWING TITLE
INTERCONNECT DIAGRAM
MODEL 2860
SHEET 1 OF 1